

BALDWIN: FIFTY YEARS AT EDDYSTONE

Book 1

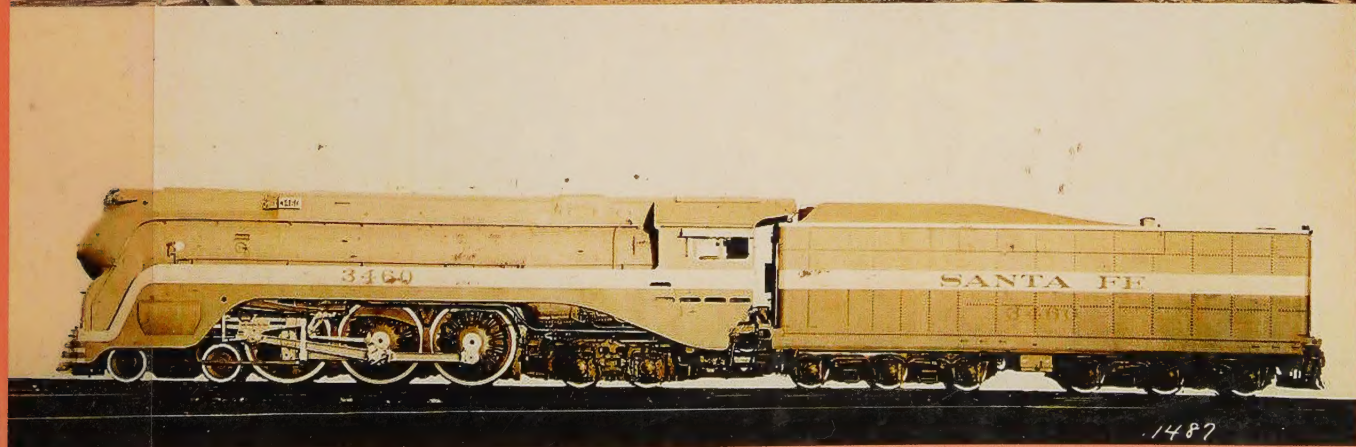
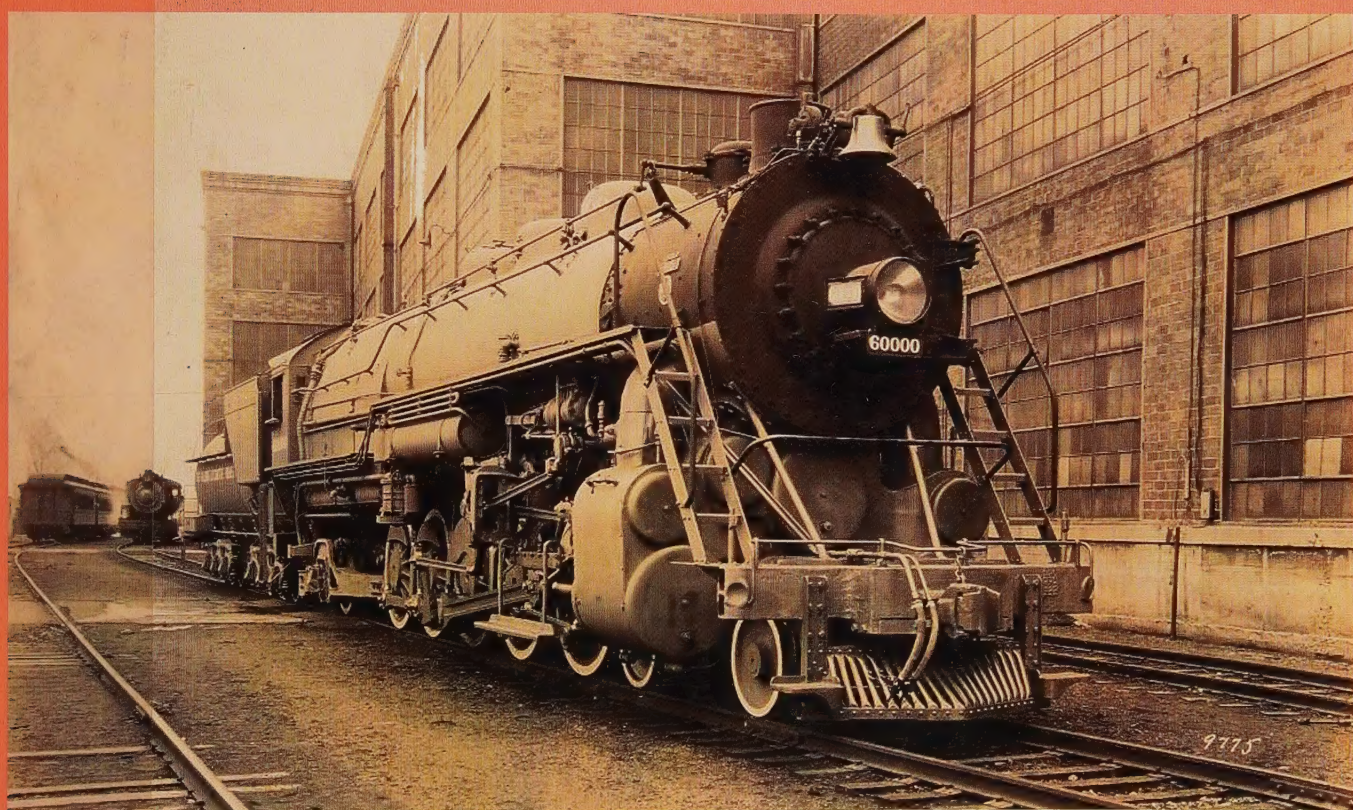
1906 - 1939

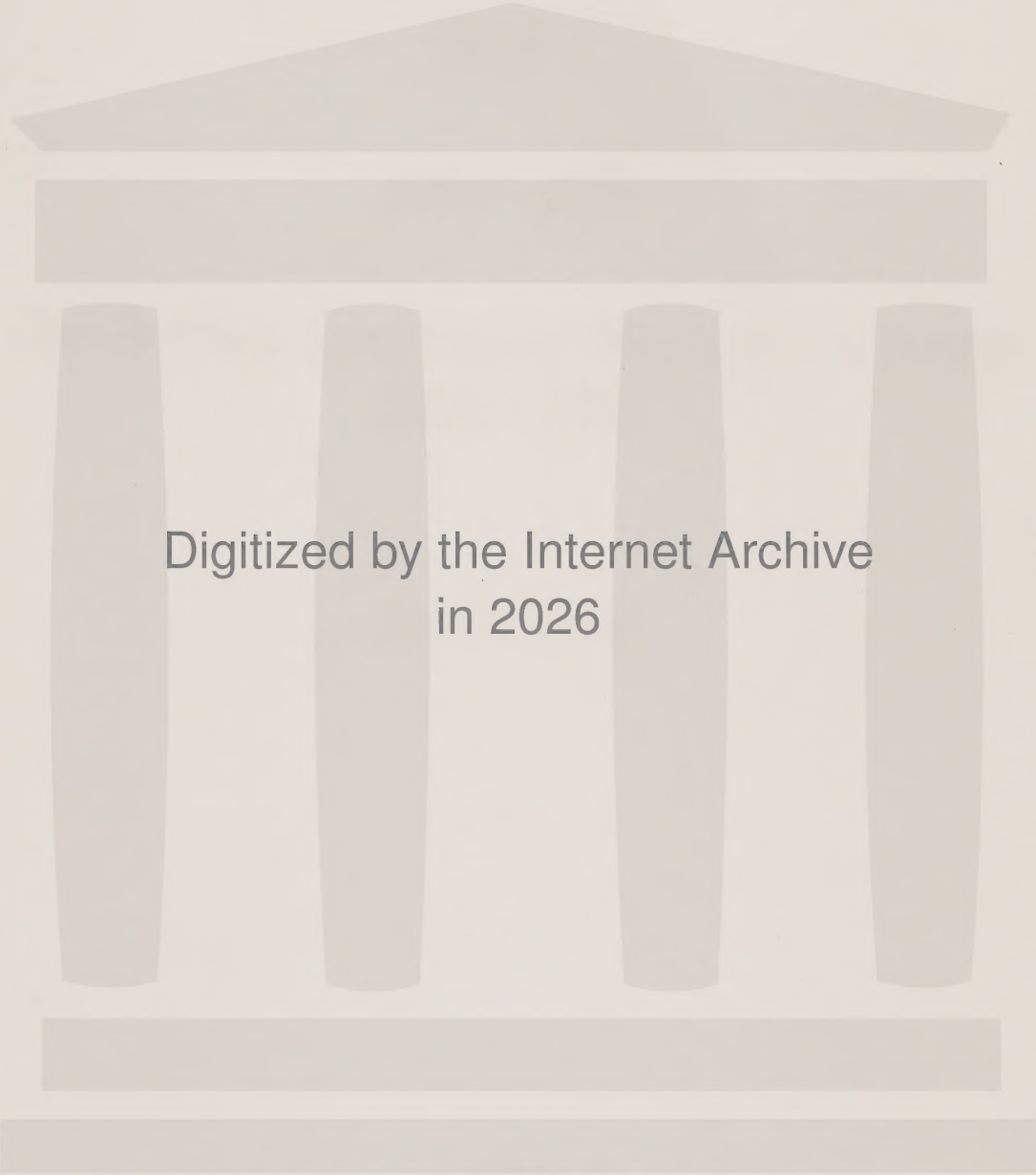
The Baldwin Locomotive Works at Eddystone

1906 - 1956

Scott D. Trostel

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*The Baldwin Locomotive Works at Eddystone
1906 - 1956*

Scott D. Trostel



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PREFACE

The Baldwin Locomotive Works is synonymous with steam railroad locomotive construction. It was a single site manufacturing plant until the upturn of business in 1906, when expanded foundry and machining capacity became necessary. Instead of attempting to buy ground somewhere in the immediate Philadelphia neighborhood and build another multi-story building, they bought the Gunsen Iron Foundry at Eddystone, Pennsylvania, twelve miles south. The foundry and 180 acres of pasture land comprised the first modest investment in what would become a 600 acre manufacturing complex. It was a gem in a highly concentrated manufacturing center on the Delaware River

Baldwin practiced vertical integration manufacturing long before that phrase was ever trendy. At differing times they owned all the raw materials, all the necessary manufacturing via steel mills, and fabrication plants to produce every single component for a locomotive. Eddystone itself was first expanded in significant ways at the start of WW I as a defense plant to handle military needs including munitions, rifles, bullets, shells, canons, speciality guns and canons plus non-rail vehicles such as army trucks. With the union situation at the Broad Street plant and its limitations of physical size, at the end of WWI the managers thought it more prudent to shift all production into the empty defense plant buildings at Eddystone during the 1920s.

The Baldwin managers got caught up in the financial misadventures of the stock trading in the 1920s and soon found themselves making more money from buying and selling paper than they made from the manufacturing of locomotives. It caught up with them when two groups of outsiders went after the Baldwin stock and soon held controlling interest, much to the chagrin of the Baldwin managers. Leading the charge were the Fisher Brothers from Detroit, Michigan, who quickly found themselves owning what had once been the worlds largest manufacturer. By 1931 the new owners found themselves holding a major business and with almost no orders and a massive physical plant and manufacturing complex to maintain. The once leading locomotive builder entered receivership, having laid off over 95% of the work force by the time of the depths of the Great Depression.

It appears that several subsidiary holdings generated much of the meager profits of the 1930s. The Baldwin position as a railroad technology leader suddenly disappeared and along with it much of the fame the Company had enjoyed. Had it not been for WW II and orders for locomotives and war materials, the firm likely would not have survived. After the war ended in 1945, Baldwin floundered again, it was ten years behind its competition in diesel-electric locomotive development and lost most of its available market. By the early 1950s it was known that the use of steam locomotives would end within a few years. The lack of a reliable selection of standardized diesel-electric locomotives spelled the end of the long-time anchor to Philadelphia manufacturing. It merged with its competition and built highway construction equipment and replacement parts for locomotives. It stumbled on as a specialty builder of pressure vessels until finally shut down in 1972.

Today the complex is gone with the exception of the office building. A few retailers have been stores in a portion of the complex. A power generating plant sits on the site between Essington Avenue and the Delaware River. The station named Baldwin, on the Pennsylvania Railroad where commuter trains once delivered thousands of workers three shifts a day is gone, they call it progress but I really have to wonder.

ACKNOWLEDGMENTS

There are a number of people who I want to acknowledge for their assistance, Mike Pizzano the Baldwin Locomotive Works resident historian at Ridley Park. He witnessed the last of the Baldwin buildings as they were demolished and the once vibrant complex was permanently silenced.

John K. "Jack" Brown, the esteemed author and historian whose works include an outstanding volume on Baldwin Locomotive Works. He pointed me in the direction of several collections to aid in my research.

I was able to have several conversations with decedents of Samuel Vauclain and for that I am grateful. Robert Elliott, the grandson of one of the three special projects men who worked directly for Vauclain when Vaulciam headed-up Baldwin. Those were fascinating conversations that would not otherwise have come to light and answered many questions about many subsidiary firms.

A number of people with the Pennsylvania Historical Society gave direction to some surviving records and information from Baldwin. Kurt Bell stands out as the go-to person for locations of information and photos. I have also been able to talk with men associated with the Baldwin-Lima-Hamilton entity as they exited the locomotive manufacturing and became a resource for replacement parts.

Charles Bates, Curator, at the Allen County Historical Society, Lima, Ohio, and home to a large portion of the Lima Locomotive Works collection came up with a number of resources when things ground to a halt during research. Their extensive railroad archives hold much of the history of the industrial and railroad transportation past.

Jerry W. Fisher, who has been a mentor for many years and whose extensive library was always available for reference.

Rachael Cron, one-time historian/archivist for the Flesch Public Library brought in many of the Philadelphia suburban newspaper files for my gleaning. Many an evening I sat in her department quietly reading newspaper microfilm to find the story of Eddystone, its development and operation as one of the leading United States businesses of the late 19th and early 20th centuries.

For those who I might have missed, Thank You, your gestures are not forgotten.

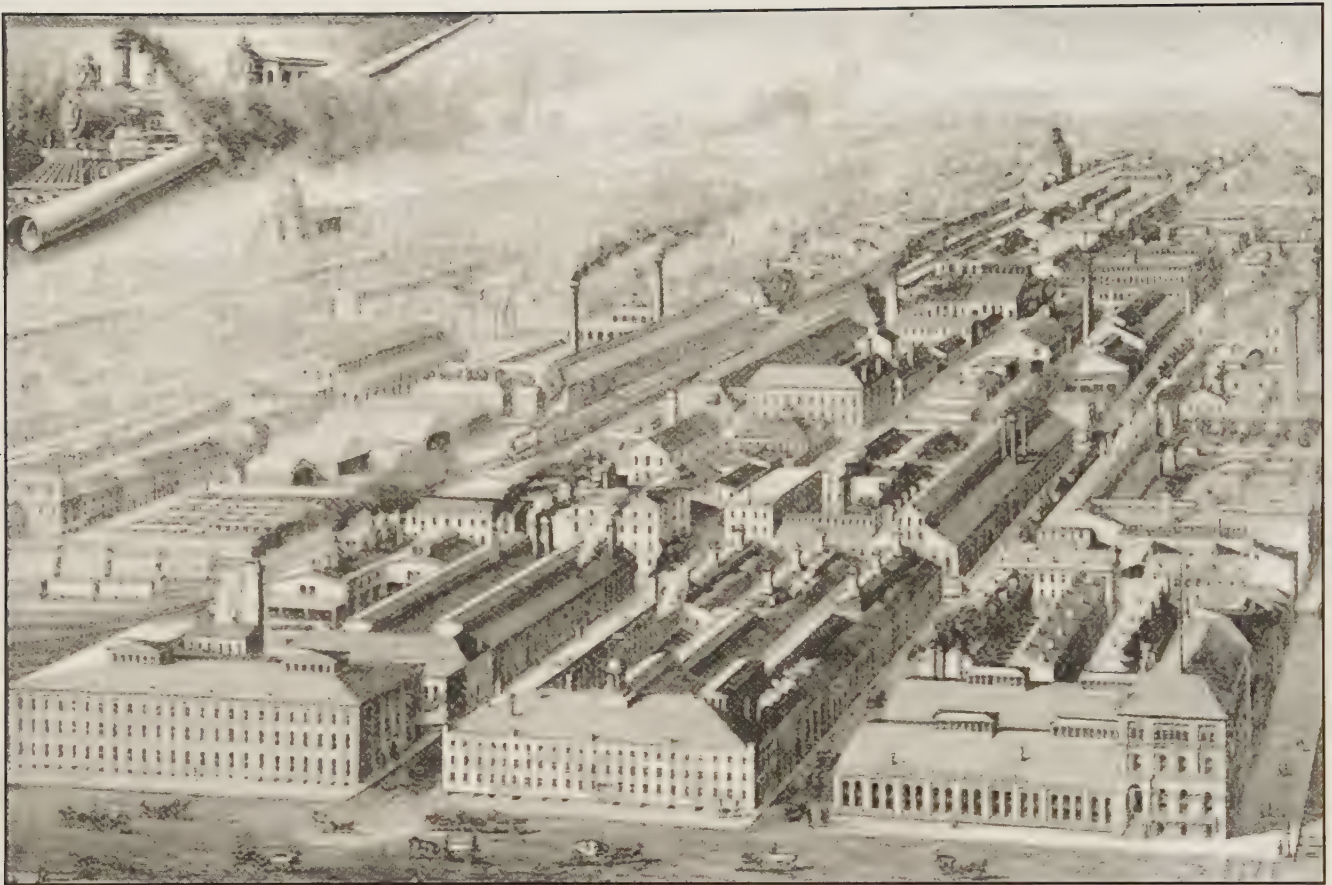
DEDICATION

To: Annie, Aaron, Samuel, Rowan and Emalyn

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Baldwin Locomotive Works, Burnham, Parry, Williams & Co., aerial view of the Philadelphia (Broad Street) complex circa 1880. It was divided into distinct manufacturing facilities by the streets of Philadelphia. The main office is in the building at the lower right. The complex faced Broad Street in the lower foreground. Right to left the intersecting streets are Spring Garden Street, Buttonwood Street, Hamilton Street and on the left with the railroad (Philadelphia & Reading Railroad) is Pennsylvania Avenue. From bottom to top the cross streets are Broad Street, 15th Street, 16th Street, 17th Street and 18th Street. The erecting shops were in the block bounded by Broad, Buttonwood, 15th and Spring Garden Streets. By the early 20th century Baldwin was confronted with the demand for larger locomotives, articulated locomotives, and a host of other technological advancements of the day, Sam Vauclain, felt additional shops were required at a site where buildings could be spread out. The Philadelphia plant had been expanding vertically for years and were not capable of further expansion to meet the changing needs for larger railroad locomotives.

The solution was to purchase ground south at Eddystone, 12 miles south of Philadelphia and to commence constructing satellite shops at that location. In 1906 the initial purchase of 184 acres was made with construction of a large foundry and blacksmiths shops following.

Baldwin: Philadelphia Locomotive Builder

Baldwin Locomotive Works was a manufacturing institution in Philadelphia, Pennsylvania by the year 1900. Started in 1831, at the very dawning of the railroad industry, they grew to employ thousands in the hot, dirty and dangerous factory buildings, where their main product, railroad locomotives of the steam and electric types were manufactured.

Baldwin Locomotive Works was located in an industrial district about 10 blocks north of the central downtown area of Philadelphia. The plant was served by an east-west branch of the Philadelphia and Reading Railroad. Unlike factories of the later twentieth century, Baldwin and many like manufacturers of heavy equipment, produced many of the component items within their factory walls, used to assemble into a completed steam locomotive. They relied on the iron and steel mills for the stocks of plate and bar stock. Baldwin owned a subsidiary company, Standard Steel Works Company who manufactured wheels, axles, some castings and even some forgings when the demand for locomotives had swamped the plant with work.

By 1900 this world renowned locomotive builder had produced over 18,000 locomotives. The partners saw no end to the growing demand for their locomotives. The firm was a partnership, and by the year 1900 known as Burnham, Williams and Company. The partners were good businessmen, and most of whom had grown wealthy and old before the golden age of railroads had begun.

The Broad Street Works was essentially landlocked, making increased production or the construction of larger locomotives difficult. One could have defined the work there as organized chaos, men almost having to step over each other, a seemingly endless clutter of work-in-progress,

one job seemingly piling over the next and the disadvantage of continually having to build larger locomotives, thus a need to make more and larger components and assemblies.

As demands for locomotives grew throughout the late 1890s, neighboring buildings were purchased, several times buildings were remodeled with additional floors added to create more manufacturing space. The main plant covered nine blocks, and included the partial closure of two streets, but yet three blocks of those manufacturing facilities was separated by the factories of William Sellers & Company and the U. S. Mint.

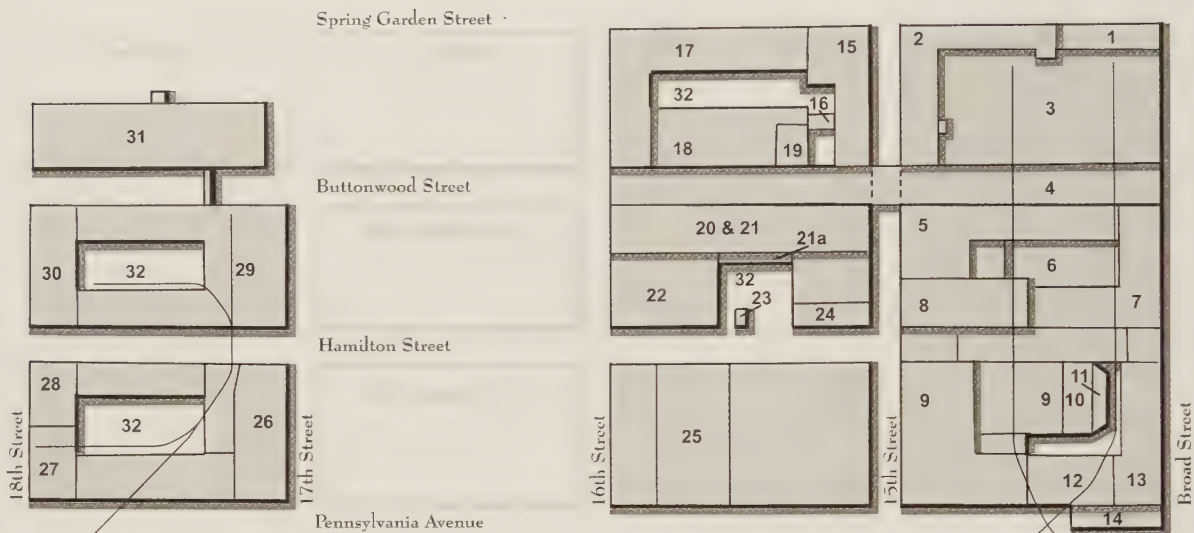
As the year 1903 opened, the cramped conditions of the factory forced the partners to locate a satellite locomotive finishing plant at 26th Street and Pennsylvania Avenue, several blocks to the west. This was a 27 stall roundhouse with an 80 foot turntable where finishing and testing of the locomotives was completed. A tender shop was also located there to the east of the subway ditch for the Philadelphia & Reading Railroad and the Baltimore & Ohio Railroad. They were forced to put some forging work to their Standard Steel Works subsidiary. The circumstances of customer requirements that Baldwin could not control largely surrounded the continually growing weight and size of the newest locomotives. Because Baldwin was a custom machinery builder, it was at the mercy of the railroads for designs, and no matter how hard they might have tried, the railroads had final say over design specifications and sometimes the delivery schedule. Internal to the inefficiencies in the flow of production, the erecting shop was at the wrong end of the facility and was a handicap to handle the construction of heavy main line locomotives demanded by the railroads. It was a seriously congested factory

Baldwin's Philadelphia Plants

THE BALDWIN LOCOMOTIVE WORKS

Facilities map - Broad Street Works at Philadelphia, Pennsylvania

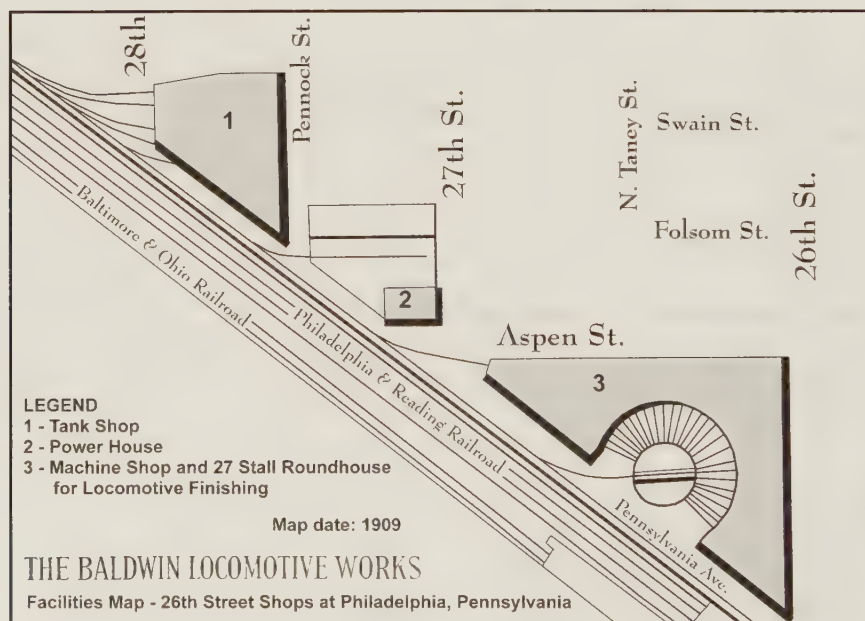
Circa 1905



Philadelphia & Reading Railroad

LEGEND

- | | | |
|---|--|---|
| 1 - Office | 11 - Boilers | 22 - Power House |
| 2 - Garden Street Shop | 12 - Willow Annex | 23 - Scale |
| 3 - Erecting Shop | 13 - Willow Street Bldg (6 Floors) | 24 - Repair Shop (4 Floors) |
| 4 - Overhead | 14 - Shed | 25 - Flange Shop |
| 5 - Boiler Shop (2 Floors) | 15 - Pattern Shop | 26 - Tank Shop (4 Floors) |
| 6 - Wheel Shop | 16 - Lab | 27 - Wood Mill |
| 7 - Hamilton Street Machine Shop (4 Floors) | 17 - 16th Street Machine Shop (6 Floors) | 28 - Smiths |
| 8 - Brass Shop (3 Floors) | 18 - Boiler Annex | 29 - 17th Street Tender Shop (4 Floors) |
| 9 - Hammer & Smiths Shop (6 Floors) | 19 - Cores | 30 - Tender Shop (4 Floors) |
| 10 - Power House | 20 & 21 Boiler Shop & Foundry (2 Floors) | 31 - Store Rooms |
| | 21a - Cupolas for Iron Furnace | 32 - Yards |





Baldwin Locomotive Works near downtown Philadelphia, Pennsylvania. This is the 16th Street Machine Shop at the corner of 16th Street and Spring Garden. This six story building held many machine tools used to make the parts for Baldwin locomotives. Locomotives had grown too big for the size of the buildings used to manufacture and assemble the parts. Coupled with peak demands for more locomotives, the managers of Baldwin began thinking about expanding their plant outside of Philadelphia. The vertical movement of parts and materials and cramped working space brought the principals of Baldwin to seek a new site at Eddystone and construct a massive new manufacturing facility. In the distance to the left is the Erecting Shop, and in the far left under the church spire is the General Office for the Baldwin Locomotive Works at the corner of Spring Garden and Broad Streets. Photo circa 1900. -- *Kings Views of Philadelphia* © 1900 Moses King

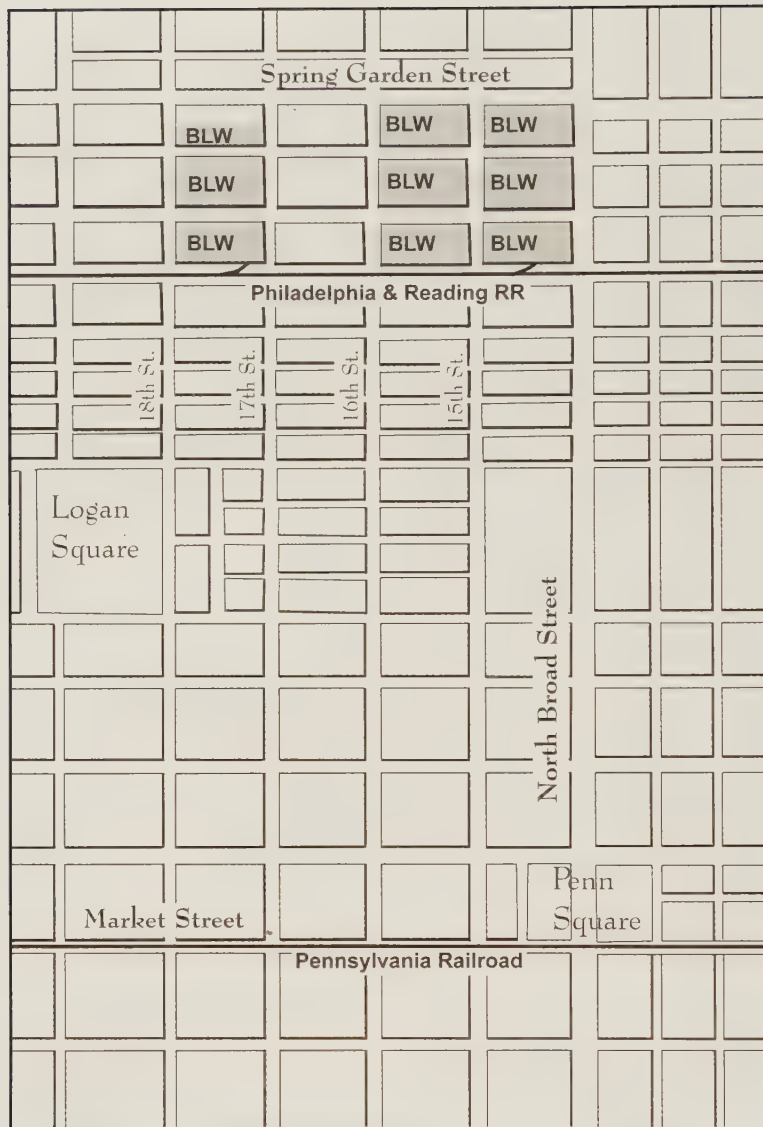
and would have withered without the necessities of future space and heavier mechanized machinery to meet the locomotive construction requirements placed upon it after 1897.

The Story of Eddystone makes the problem very clear: “By 1907 locomotives had become so large that it was all but impossible to get them out of the Philadelphia plant. At times wheels had to be jacked up, side frames of doorways cut out [of the buildings] and switch lamps removed in order that the engines could be moved to the railway for shipment. The erecting shop was congested and the movement of materials slow and costly.”

Defining the problem, the managers had come to know the key to efficient and profitable construction was not in vertical expansion of facilities but in horizontal expansion, therefore they could

build the smallest industrial locomotive or the newest advancement in locomotive technology, the massive articulated or two-in-one locomotive as General Superintendent Samuel Vauclain referred to them. At the Broad Street Works, boilers were manufactured on two floors, tenders were fabricated on four floors in buildings that were four blocks west, the smith and hammer shops covered six floors and a multiple of machine shops covered from four to six floors in scattered buildings. This was hardly efficient or cost effective. Interrupting production, finished locomotives had to be moved through the boiler shop, smith and hammer shop, machine shop and other areas in the plant before they ever rolled into the light of day.

Compounding those problems, the Philadelphia & Reading Railroad, which at one time had



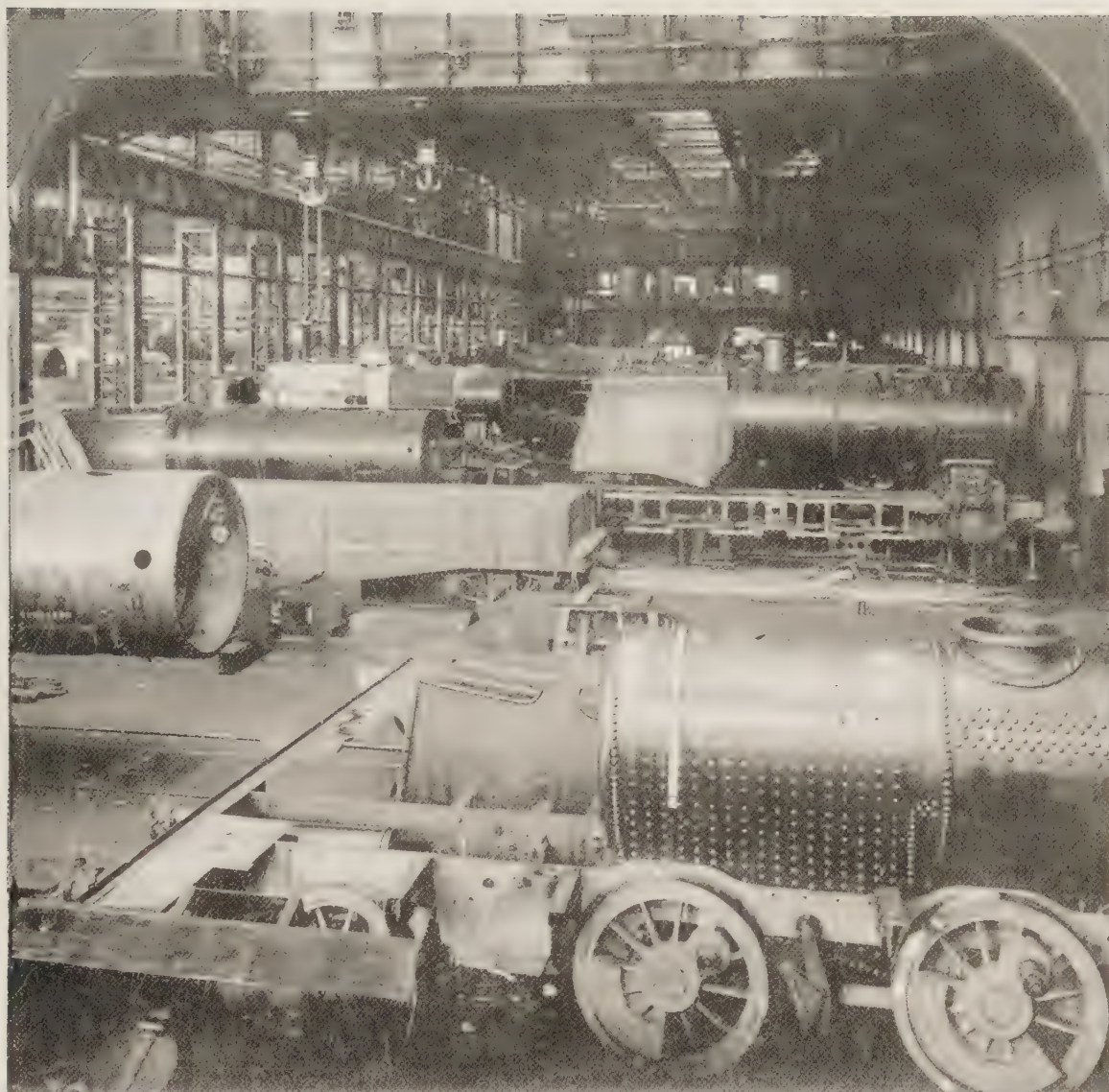
BALDWIN LOCOMOTIVE WORKS Broad Street Plant site in downtown Philadelphia, Pennsylvania circa 1900. Compare this map to the map of Eddystone on page 59. - Map drawn by author

been at street level on Pennsylvania Avenue, had, by the 1890's, put its tracks into a subway trench, further limiting any potential for relaying the factory tracks, especially in easing curves as the demand for the newest and longer wheel base locomotives demanded.

The pressures of rapidly increasing orders, after a return of the economy during 1898, brought Baldwin managers to begin talking about a new

plant site that could bring all manufacturing down to one or two floors, and would accommodate the largest locomotive that the future could present. By 1902 managers were seriously talking about plant expansion and had begun looking for new plant sites. Some partners of this firm were not unanimous in their desires for expansion.

Samuel M. Vauclain, General



This view is inside the Broad Street Erecting Shop circa 1914. Any erecting shop was always a scene of chaos, but this one was also cramped. The bays were small and the lead tracks to get completed locomotives out the door was three blocks away through other buildings and departments. All bays were stub tracks and overhead cranes were used to move both parts and completed locomotives through the building. -- *Author's collection*

Superintendent

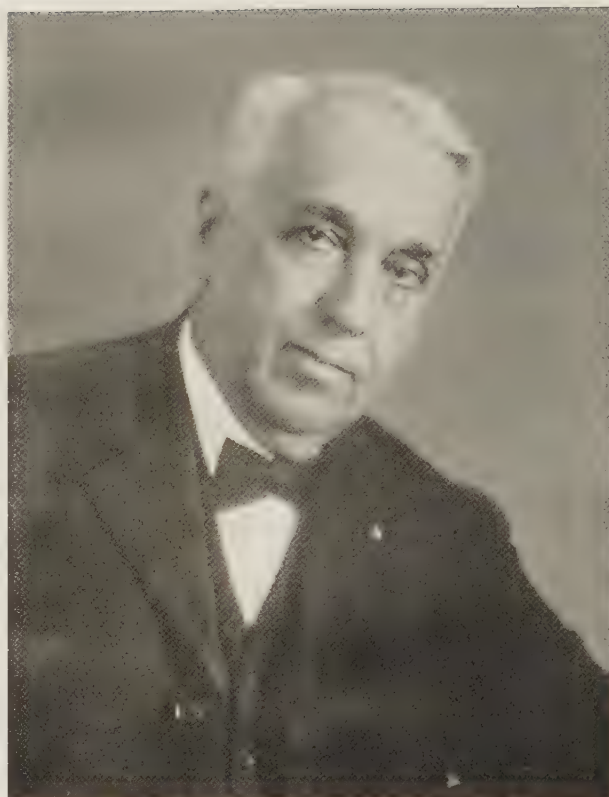
Samuel M. Vauclain was General Superintendent of Baldwin Locomotive Works by 1900. He was a driven person, charismatic, a self-promoter and salesman with a flare for engineering and the gift to turn his ideas into reality in big ways. He had risen through the ranks of the railroad locomotive builder, serving a term with the Pennsylvania Railroad at their extensive

Altoona, Pennsylvania Shops. There he apprenticed into the machine shops, starting at age 16. He went to Baldwin Locomotive Works in 1883. His father, Andrew, had been an early employee under Mathias Baldwin. Sam rose rapidly through the ranks and by 1896 was a full partner in the entity of Burnham, Williams & Co. From the year 1900 through 1906, the Philadelphia Works had turned out no less than 1,200 locomotives per year, and in the bench mark year of 1906, they

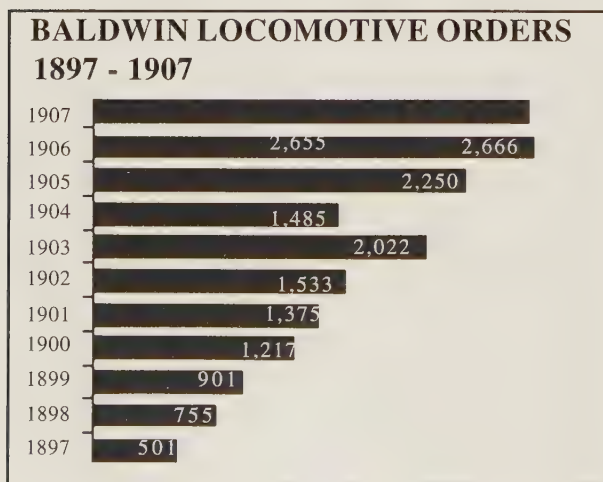
produced 2,666 locomotives, employing 17,432 men. The Broad Street Plant had no room to grow for what was envisioned as a continuation of high demand for its locomotives. The erecting shop of 1869 had been replaced by a newer and larger shop in 1890 which advertised 19 tracks for locomotive assembly and an average of four locomotives per track. The problem with the new erecting shop, it was moved further back into the complex and more distant from the railroad connections which meant continued problems in getting the finished locomotives out the doors of the plant.

Between the years of 1902 and 1907 a number of expansions were undertaken to improve production and to meet new orders at the locomotive builder. They had gone to working multiple shifts to get higher utilization from the production machinery, hired more men and tried to expand the plant within the confines of limited available space.

Between the dramatic growth in orders and the increasing size of the newest design for locomotives, Baldwin struggled to keep pace. It appears the newly invented articulated or two-in-one locomotive was welcomed by the Baldwin sales department with a great deal of enthusiasm. It was just what the railroads needed, two engines under one boiler, a hinged frame to handle tight curves and it only required one engine crew to operate. Vauclain and his engineers embraced it but the locomotives was too much for the cramped



Samuel M. Vauclain, the driven mechanic who rose through the ranks of Baldwin Locomotive Works to become president and saw to the construction of the Eddystone Works. He held patents for both machine tools and improvements to locomotives constructed at BLW. Vauclain lived long enough to see his dream completed at Eddystone and to witness the financial collapse of the Company. -- *History of The Baldwin Locomotive Works.*



Broad Street Works to easily handle. When the first order came in for the first five 2-6-6-2's from the Great Northern, it was as big a challenge to manufacture and assemble them as had ever been laid in the plant. The only solution to the problem, another expansion, this time to build a whole new facility where they could not only build the 2-6-6-2 but larger articulated locomotives including the 2-8-8-0, 2-8-8-2 and in a few years the 2-10-10-2, 2-8-8-8-2 and even the single Virginian 2-8-8-8-4.

Vauclain and his partners forming the Burnham

Baldwin Locomotive Works

Builders of

Single Expansion and
Compound Locomotives



ADAPTED TO EVERY VARIETY
OF SERVICE.

ANNUAL CAPACITY 1,000.

BURNHAM, WILLIAMS & CO.

PHILADELPHIA, PA., U. S. A.

As locomotives increased in overall size, weight and length, it became increasingly difficult for the Broad Street Plant to meet customer requirements. When the articulated locomotives appeared just into the early 1900's, that next step in locomotive technology required longer and larger facilities in which to assemble the locomotives. Baldwin met that need with construction of a modest building at Eddystone where the articulated locomotives were assembled. All components were initially manufactured at the Broad Street plant in Philadelphia. Baldwin Locomotive Works advertisement for 1899. -- *The Locomotive Up To Date 1899*

Williams & Co., began looking beyond the limits of Philadelphia, eyeing the property of a failed iron works on Crum Creek and the Delaware River about 12 miles south of the Broad Street Plant. On May 6, 1906, within the rural borough of Eddystone, Baldwin purchased an initial 184 acres and immediately laid plans to move all foundry, smith and hammer operations, scattered over six floors in the existing plant to those of an entirely new shop at Eddystone. They needed to bring other foundry and blacksmith work subcontracted to Standard Steel and others into a larger central complex on the newly acquired property.

Eddystone Conceived

On January 1, 1896, three of Baldwin's managers were admitted to the partnership; Alba B. Johnson, Samuel M. Vauclain and George Burnham Jr. Burnham retired in December 31, 1906 leaving the Johnson and Vauclain to start on a journey of personal and corporate expansion the likes of which had not been seen since the Captains of Industry of the 1870's and 1880's and their industrial and transportation monopolies.

As the industrial revolution matured in the late 19th century, railroads shifted their focus from building new lines to moving freight more efficiently. Both technology and government regulation brought the railroads to considering improved and more efficient locomotives to move the trains. By the early 20th century the railroad car builders had moved from wood as a principal building material to that of steel, a ferrous alloy of high strength. In the age of growing car capacity, steel allowed the cars to carry heavier loads without greatly adding to the weight of the car body. Cars of wood construction had reached their zenith and could not match steel as the material of choice. Car wheels and couplers also quickly changed from iron to steel. The locomotive builders, as custom builders were forced to satisfy their customers' demands for more powerful, and larger locomotives to handle heavier trains. New wheel arrangements and bigger designs were arriving on the shop floors, the articulated locomotives such as 2-6-6-2, 2-8-8-2, 4-8-0 and 2-8-2. Even tender tractors including complete locomotive drive trains were being developed to give the locomotive more power.

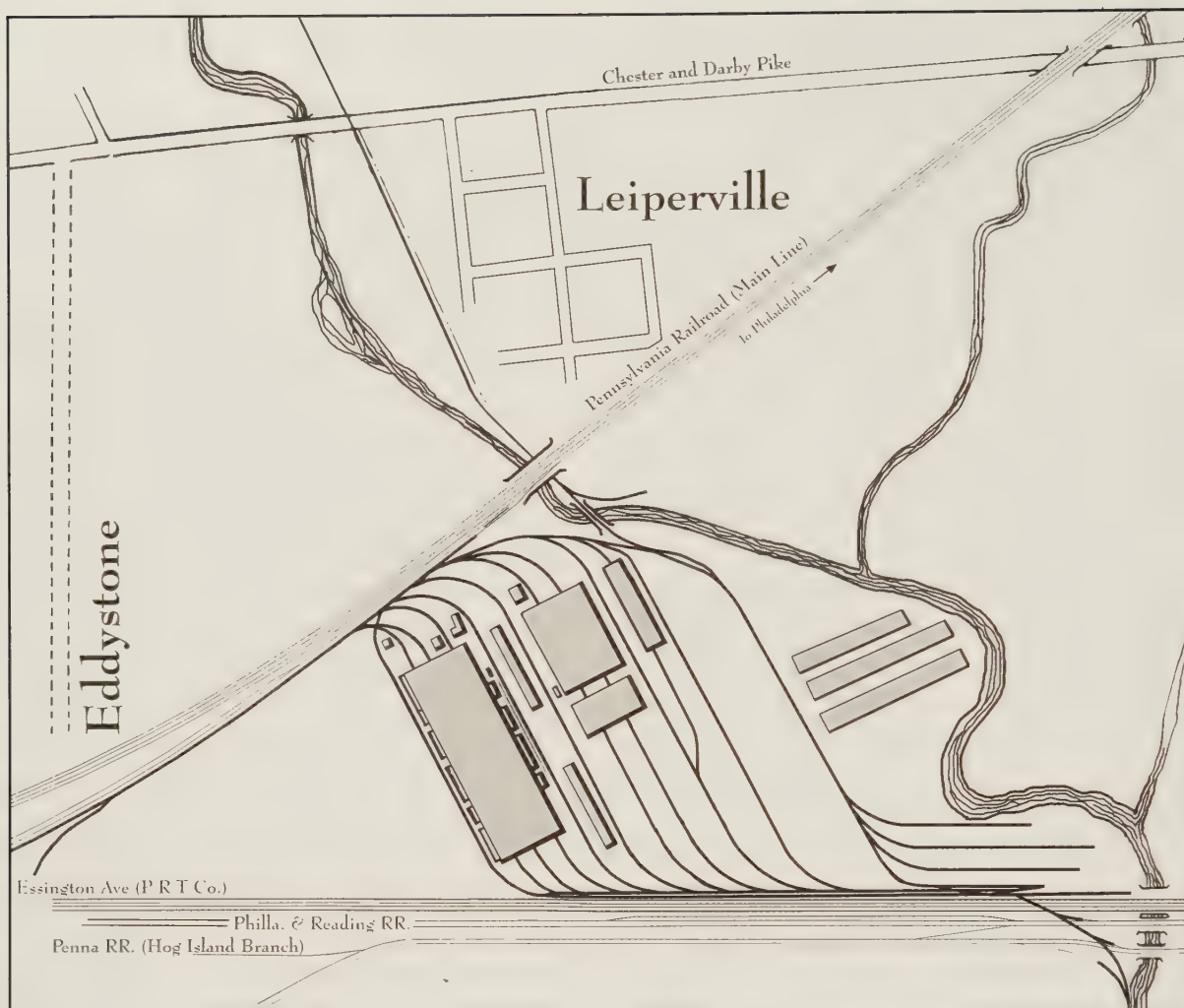
Baldwin Locomotive Works in the industrial district of Philadelphia, Pennsylvania was assembling larger locomotives that were increasingly difficult to manufacture in cramped facilities and difficult to get out the factory doors. Door frames were removed, lamps removed from switch stands and aisles cleared to get completed locomotives from the erecting shop buried at the north end of the complex at Broad and Spring Garden Streets, three

blocks south, passing through their boiler shop, wheel shop, machine shop and other buildings, finally coming into the light of day at Pennsylvania Avenue and a connection with the Philadelphia and Reading Railroad.

The management of Baldwin Locomotive Works began looking for a site on which to place some foundry and machining facilities housed at Broad Street. After several studies they focused on a site at Eddystone, some 12 miles south of Philadelphia. The initial purchase was the property of the Gunsen Iron Works. The initial need for the fail iron works was to add internal capacity to the iron foundry department of Baldwin. A triangle of land fronted by the Chester Pike and surrounded by the Pennsylvania Railroad, the Philadelphia and Reading Railroad and Crum Creek. The eastern portion was a marsh fronting on the Delaware River, a river which had the capacity to handle ocean going ships.

Aside from the Baltimore & Ohio's original 0-6-6-0's, built by the American Locomotive Company, Baldwin built its first three articulated locomotives, small meter gauge 0-6-6-0's exported to the American Railroad of Puerto Rico in November 1904, c/n 24827 - 24829. Baldwin quickly embrace articulated power, but orders were slow in coming.

After a sales trip west by Sam Vauclain, he convinced James J. Hill, president of the Great Northern to purchase and test five of this new 2-6-6-2 design. If they didn't work Vauclain extended Hill the offer that he would accept them back. In 1906, Great Northern took delivery of five locomotives for operation on its lines in the Cascade Mountains of Washington State. They were the first locomotives with this wheel arrangement. The two-wheel lead truck gave the engine better riding stability into curves and the two-wheel trailing truck helped support the weight of the firebox. Their success assured the partners that Vauclain was correct in his feeling that Eddystone was essential. When GN ordered more the following years, they

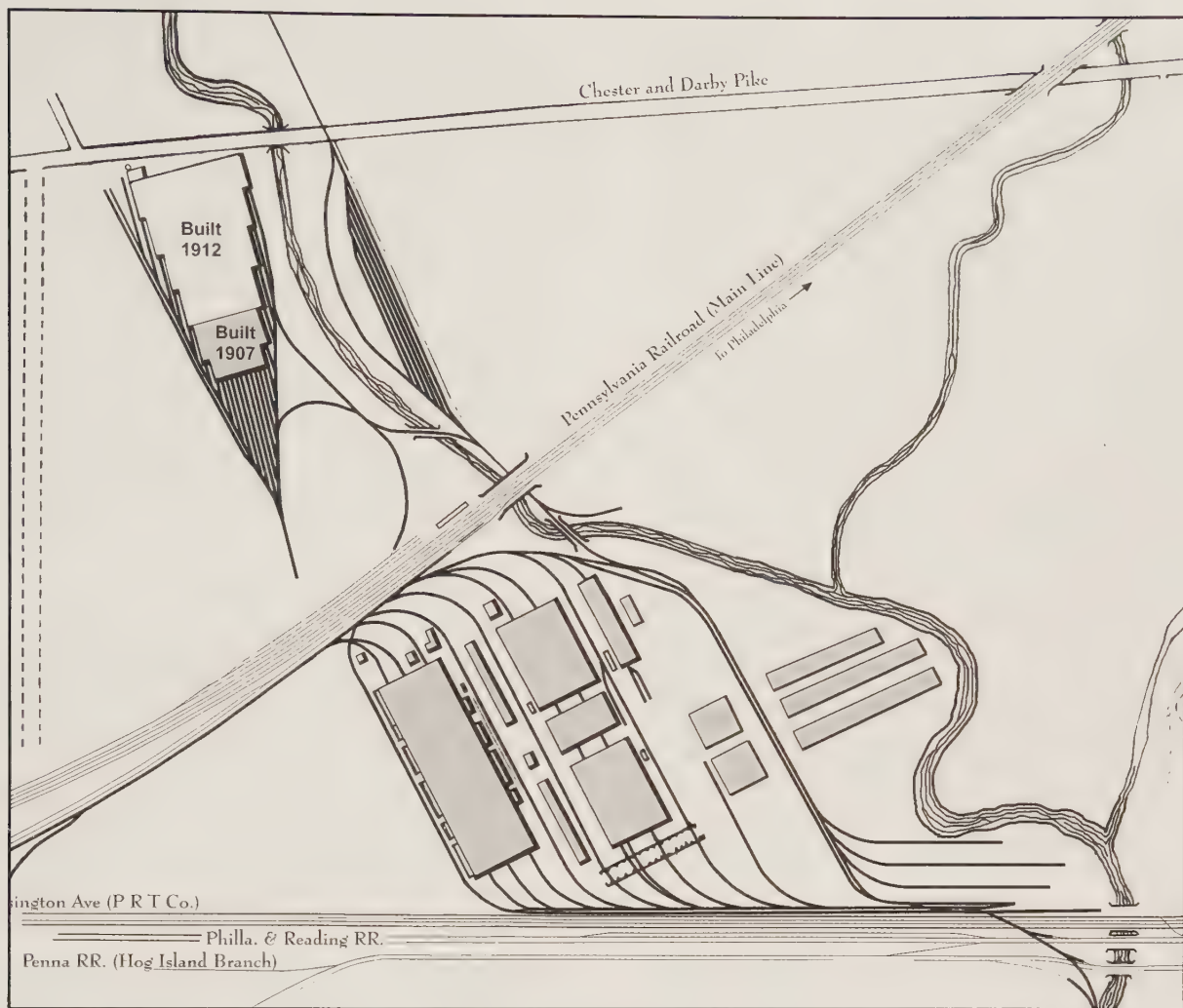


Eddystone, the last major investment by the longtime partnership of Burnham, Williams & Co., was to become an industrial complex second to none and the gem of Baldwin Locomotive Works. In this early map circa 1906, the foundry and Smith and Hammer shops are clearly visible, along with the pattern shop and several pattern storage buildings. The plant is bounded on the west by Chester Pike and on the east by Essington Avenue. It was initially served by both the Philadelphia & Reading Railroad, which served the Broad Street Plant and the Pennsylvania Railroad, which cut through the property.

were assembled at the developing site of Eddystone.

The locomotives received construction number 30400; 30422; 30445; 30446; — 3/1907 and construction number 30563; 30564; 30565; 30566 — 4/1907. The Great Northern received nine more in May, six in June and One in July. The next order of the 2-6-6-2's went to the Northern Pacific with delivery starting in July 1907. A new locomotive design had come to full reality for Baldwin.

Until the likes of Anatole Mallet, a French designer, who patented the Mallet locomotive in 1900 and Carl J. Mellin of the newly formed American Locomotive, who patented the first hinged frame articulated locomotive, Baldwin was comfortable, perhaps too comfortable as an era of growth, change and government regulation of the railroad industry had begun. They could build a variety of designs, most of which were their standard 4-4-0, 4-6-0, 2-8-0 and a few odd ball wheel



Desperate for space at Broad Street and anxious to start assembling the larger articulated locomotives, a second smiths shop was added in 1907, along with the first three bays of the first erecting shop. The first locomotives produced here were a group of 2-6-6-2 articulated for the Great Northern in 1907. Vauclain had to have the first three bays of the Erecting Shop put up in order to get the assembly crews out of the weather. The balance of that shop was completed in 1912 and put seven and one-half acres under roof.

arrangements en masse. Baldwin was offering itself as a custom locomotive builder, at its peak offering 500 designs for locomotives.

Eddystone On The Delaware

Judge Charles Grantham purchased 120 acres of farm ground in 1799 south of Philadelphia at the site of Eddystone. It sat East of Simpson Street and

ran from Chester Pike to the Delaware River. Judge Grantham raised sheep along with a few head of cattle. The property remained in the Grantham Family until 1824, when Lewis Trimble purchased the farm.

Lewis built a new home at Chester Pike and Simpson Street but sold the farm to Lewis Price who lost the property to the Bank of Delaware County. The Bank sold the property to John Willets for Richard Risley Carlisle. Carlisle was a famous acrobat and gymnast in the 1840's. Carlisle went by the

name of "Professor Risley". His two sons worked with him as acrobats and his troupe was the first to tour Japan in 1848. Carlisle lived on the farm for a while but he had bought the farm as an investment. He had financial difficulties and sold the farm in 1855.

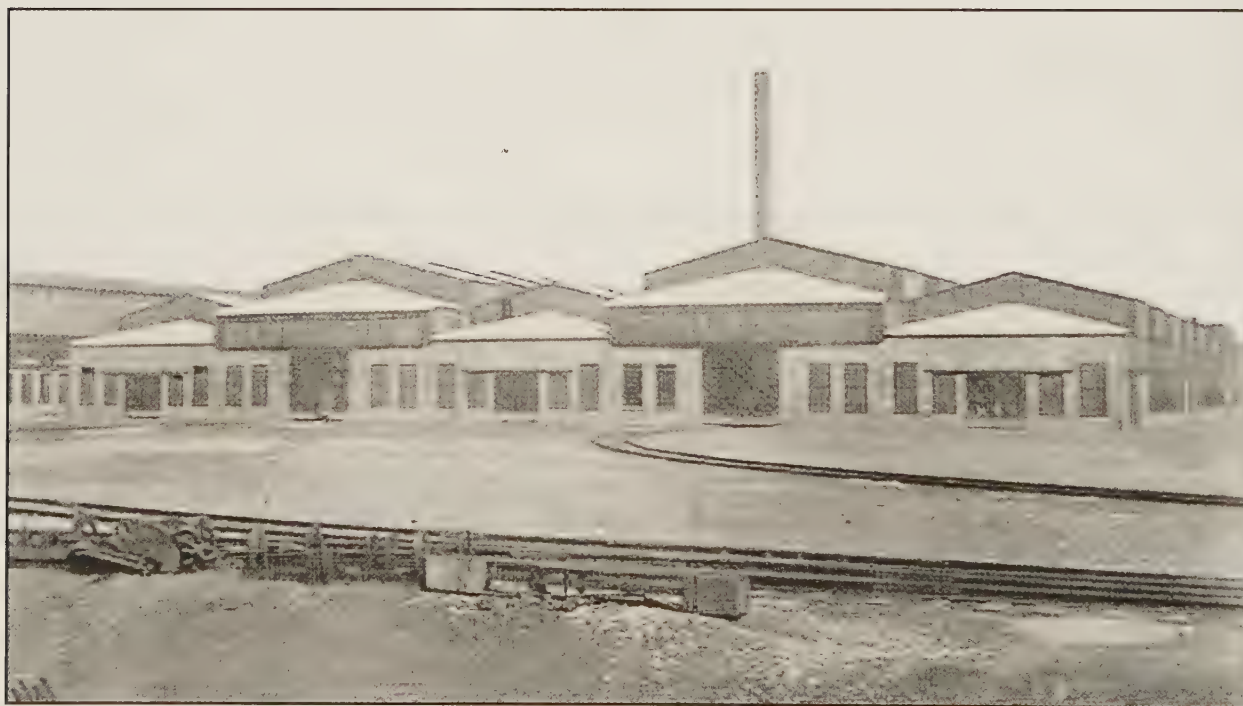
French Native Honore Denis, a chemist in Philadelphia, bought the farm, remodeled the house and used it as a summer home. Denis died there in September 1872. His son Geoffrey lived on the farm before moving to Chester where he formed an electric power company. Geoffrey sold the farm to the Simpson Family in the early 1900's.

To the immediate west of the Simpson farm was that of Charles Grantham who purchased an earlier tract of land in 1751 from the estate of one Jonas Culin. The tract totaled about 100 acres and went south from Chester Pike to the Delaware River just West of Crum Creek. Grantham died about 1770 and left this share of his estate to his son William.

During 1793 Abraham Trimble purchased the property from the Grantham Family. Trimble added several small tracts of land over several years until his property totaled about 180 acres. Trimble died on July 18, 1821 leaving a wife, Susanna, with eight children. The property was given to Abraham, Jr. in 1825 and he died in 1840 unmarried. Lewis Price, Abraham's brother-in-law, owned the property for a few years, but in 1849, Abraham T. Trimble purchased the property. It is believed he was a grandson of Abraham Trimble, Sr. Abraham, who was from Middletown Township, kept the land until 1881 when Thomas Simpson purchased the property.

Eddystone Established

This small community of Eddystone, twelve miles south of Philadelphia, was incorporated December 7, 1888 as the wings of the industrial town



Known as the Box Shop in the Eddystone complex, this facility was new when this photograph was taken circa 1907. It sat east of the Pennsylvania Railroad main line. The building was a large machine shop where driver centers, tires, wheels and axles were machined and assembled and driver boxes machined and fitted out. -- From an early post card.

started to spread. It was founded by William Simpson, founder of the Eddystone Print Works, a textile printer and major employer from the Philadelphia area.

On May 18, 1889, a United States Post Office was established in the railroad station with the Station Master John W. Armstrong acting in the dual capacity as both agent and Post Master. The village built a town hall in 1899. Alva Kerr, was the contractor. He lived in Eddystone. The bricks for the town hall came from the Fields Brothers Brickyard which stood just south of 9th Street at Eddystone Avenue. The borough hall was dedicated Thursday, December 8, 1899 just as the first large industry entered the area.

By 1899, the area was starting to see some industrial development. At the November 1899 Council Meeting, the heirs of the Thomas Simpson Estate approached the Borough of Eddystone about passing three ordinances to help establish the Grusen Iron Company. The ordinances consisted of striking several streets from the Borough's plan and exempting the Grusen Company from Borough taxes for two years. Council passed both ordinances but they had no authority to exempt the company from taxes. The tax ordinance was later repealed but the Simpson Estate paid the Grusen Company taxes anyway. The Grusen Iron Company was established and built a modest facility, but quickly failed.

Sam Vauclain and the Baldwin Locomotive Works quickly purchased the Grusen Iron Works property during May, 1906. In just one week the Iron Works had been cleaned-up and restored to working condition for the casting of iron components that Baldwin had been forced to contract out as a result of a surge in locomotive orders.

The owners felt sure the market would hold up and Baldwin would lead in the manufacture of railroad locomotives.

Alba Johnson had expressed that more and more, their suppliers were establishing manufacturing shops in the Chicago and St. Louis area and they would need to establish a fourth manufacturing site in the Chicago area.

In anticipation of establishing a third site in the Philadelphia area for the manufacture of locomotives, castings were the first items to be turned out by the newly established Eddystone Works of Baldwin. During the balance of 1906 several buildings were constructed for the machining and assembly of running gear components for locomotives.

A New Design - Articulated Locomotives

George Burnham, Sr., who entered the Works in 1836, died at his home in West Philadelphia on December 10, 1912, in the ninety-sixth year of his age. Mr. Burnham had been a member of the firm since 1867.

The financial panic of 1907-1908, resulted in the volume of business handled by the Works falling off rapidly. There had been no further investment in construction of new facilities at Eddystone since the initial construction in 1906 and early 1907. The year 1908 saw 617 locomotives produced, only 23 percent of the 2,655 locomotives produced in 1907. Of that total, 174 were for export. The year 1909 saw 1,024 locomotives roll out the doors with a reasonable boost in orders for 1910 of 1,075 locomotives; 1911, 1,606 locomotives and 1912, 1,618 locomotives for about 60% of manufacturing capacity.

Burnham, Williams & Company Dissolved

On January 1, 1909, the partnership, of Burnham, Williams and Company was dissolved. The 19th century partnership had passed. In its place the privately held stock company of Baldwin Locomotive Works was incorporated. The officers included John H. Converse, President; Alba B. Johnson, Vice President and Treasurer; William L. Austin, Vice President Engineering; Samuel M. Vauclain, General Superintendent; William deKraft, Secretary and Assistant Treasurer.

With the upturn in business in 1910, the corporation issued a mortgage bond for \$10 million to fund working capital needs.

The corporation continued to grow so rapidly that by April 1911, it became necessary to reorganize with the introduction of \$40 million in new capital. This was done by two financial firms selling the first public offering of Baldwin stock. They

formed a financial holding Company in the name of Philadelphia Locomotive Work and brought with them the introduction of additional Directors representing the new capital to the Baldwin Board. The recapitalization was for \$20 million of seven percent preferred stock and \$20 million in common stock. This nearly doubled the capital of Baldwin, but greatly diluted the formerly closed control.

The deal did not sit well in some financial circles. By early 1914, Jacob H. Schiff of Kuhn, Loeb Co. testified in the suit, which George H. Robinson had brought before Judge Hand in the Federal District Court. He sought to recover from Alba B. Johnson \$500,000 to \$900,000, which, he asserted, would have been his commission, if the Baldwin Locomotive Works (stock) had been sold to Kuhn, Loeb Co. instead of to Drexel Co. and White, Weld and Co. It proved to be a distraction of little worth as new technology and new business lines developed. It did however subtly signal the beginning of an adversity in the management of the growing corporation that would seriously haunt them by 1927.

Sam Vauclain was heavily promoting his patented articulated and hinged boiler locomotives in place of the earlier Vauclain Compound designs. These new locomotives were so large they could only be assembled at the Eddystone facilities.

The first new construction undertaken at Eddystone was the completion of the Erecting Shop in 1912 and the addition of a second Smith and Hammer Shop by the end of 1912 over 500 men were employed at the new Eddystone shops.

Eddystone was considered as an assembly plant for articulated locomotives. All the finished parts were transported twelve miles from Philadelphia for those locomotives being assembled at the new Eddystone Erecting Shop. It is not known whether individual parts were shipped down, or whether some subassemblies were partially completed at

Broad Street and sent down for final assembly. Once assembly was completed the locomotives were transported back to the 26th Street Finishing shop west of the Broad Street plant for jacketing, paint and other final touches prior to being shipped.

A New Technology - Articulated Locomotives

The first articulated locomotive built for any United States railroad was built by the newly formed American Locomotive Company in 1904, an 0-6-6-0 Number 2400 for the Baltimore & Ohio Railroad (*ALCO c/n 27478*). It was an immediate success.

Carl J. Mellin, of Schenectady, New York, employed by the newly formed American Locomotive Company, is clearly the father of the “American articulated” type locomotive. Patents defined the articulated locomotive as having wheels carried on a rear frame and independent front frame, pivotally connected by a pin which allowed it to swivel freely.

The designer of the Number 2400 was John E. Muhlfield, General Superintendent Motive Power for the B & O. He greatly refined the invention of Anatole Mallet, in ways that gave the American railroad industry a more powerful and less expen-

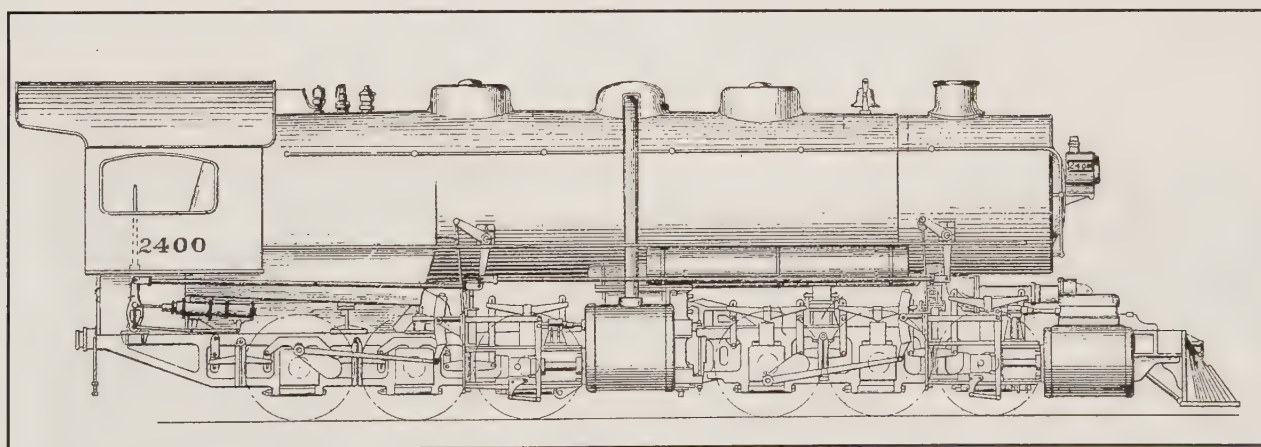
sive form of motive power, although Mallet hardly recognized his original design.

The Number 2400 was reported to have weighed 477,870 pounds including its tender. These heavy locomotives were assigned to Sand Patch on the B & O main line where they worked for many years.

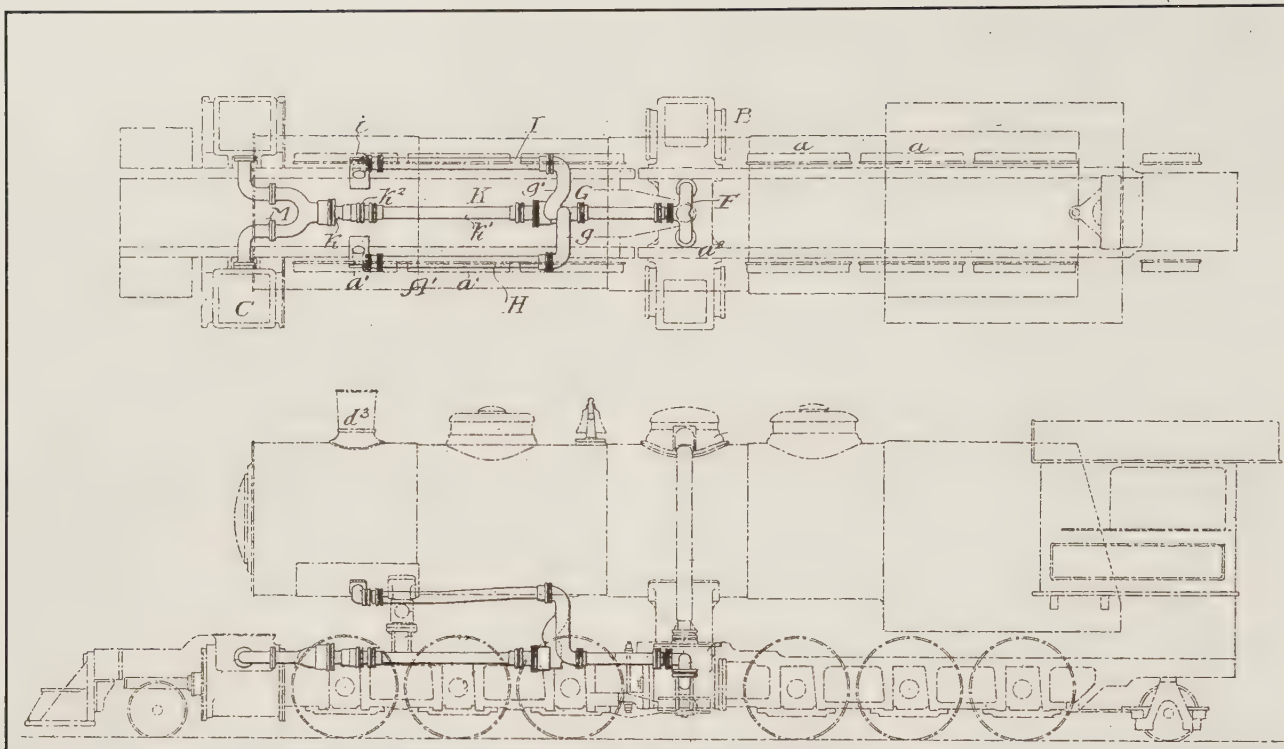
Within a short ten years the mallet-articulated locomotive took on many designs and wheel arrangements, with competing Baldwin Locomotive Works taking a strong lead in its future designs and refinements. Because it was essentially two locomotives housed under a single boiler, it saved crew costs normally associated with the use of a second locomotive. It also used steam twice, passing steam from the small high pressure cylinder to the larger low pressure cylinder before exhausting it to the atmosphere.

Samuel Vauclain quickly realized this type of locomotive would rapidly replace his Vauclain Compound and directed Baldwin’s engineering staff to devote their efforts toward designing a broad group of articulated locomotives.

Vauclain and his consulting engineer, George Henderson both quickly picked up the idea and added third, fourth and fifth frames under locomotive boilers and tenders in an effort to create more powerful locomotives. Some of their designs were



The first articulated locomotive built for any United States railroad was built by the American Locomotive Company in 1904 for the Baltimore & Ohio Railroad. Samuel Vauclain realized this type of locomotive would quickly replace his Vauclain Compound and directed Baldwin’s engineering staff to devote their efforts toward designing a broad group of articulated locomotives. These locomotives had a great deal to do with the establishment of locomotive assembly at Eddystone -
- United State Patent Office Patent Number 852444



The first articulated locomotives built by Baldwin Locomotive Works for any United States railroad were the Great Northern 2-6-6-2s. Illustrated above was the 2-6-6-2 wheel arrangement type locomotive. The first five were built at the Broad Street and 26th Street Works in Philadelphia in 1905. When the order for 25 additional articulated locomotives came in from GN, the Broad Street plant was swamped with orders. Vaclain directed that three bays of an erecting shop be constructed at Eddystone and the locomotives be assembled there. Those actions resulted in the establishment of locomotive assembly at Eddystone -- *United State Patent Office Patent Number 852444*



This photo shows Great Norther 2-6-6-2 Numbers 1800-1804 ready for shipment out of Baldwin Locomotive Works on the Philadelphia & Reading Railroad in the year 1906. Note the main rods are down, as are the eccentric rods. The headlights, cab doors and windows are also boarded over, typical of new locomotives being delivered dead-in-tow.

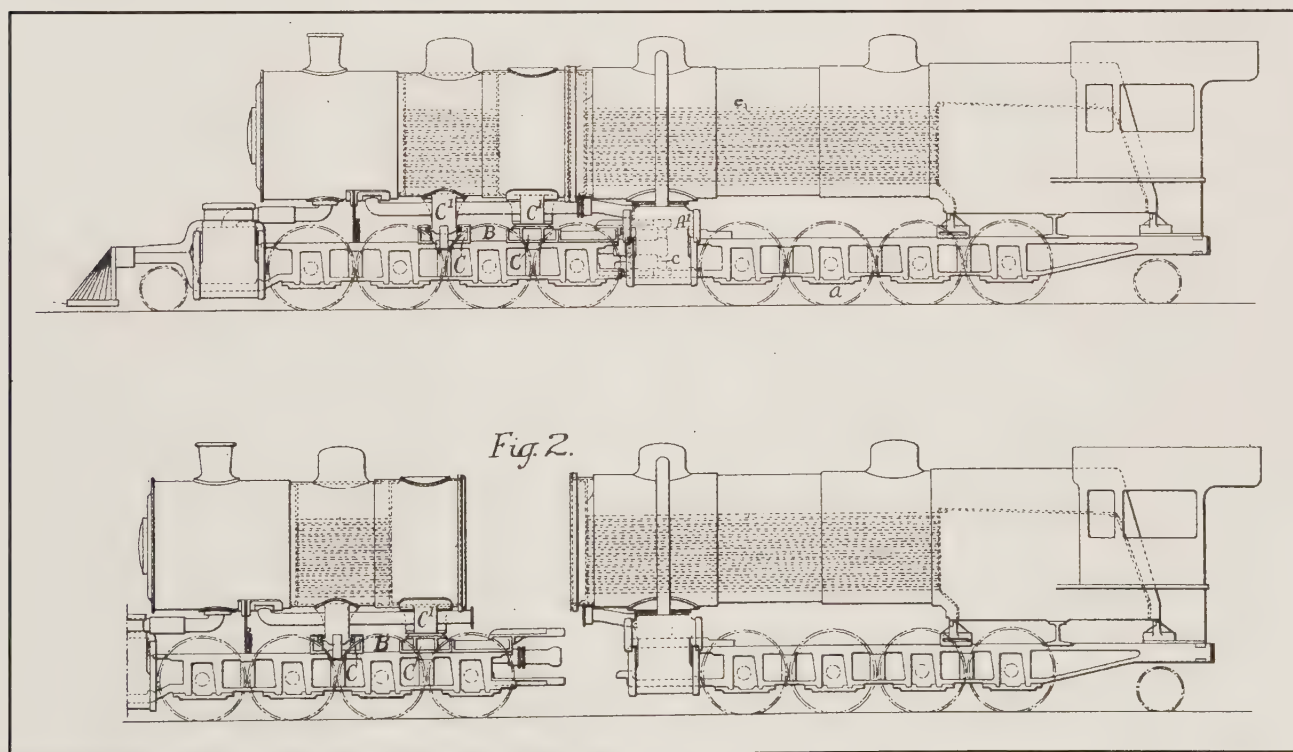
were pulled, especially up steep grades, was an excellent application for the articulated locomotive.

Short line and narrow gauge railroads where curves were often of relatively tight radius and where grades would significantly exceed those allowed in main line railroad construction gave rise to the hinged frame, thus lowering the wheel base length while increasing tractive effort of the added driving wheels.

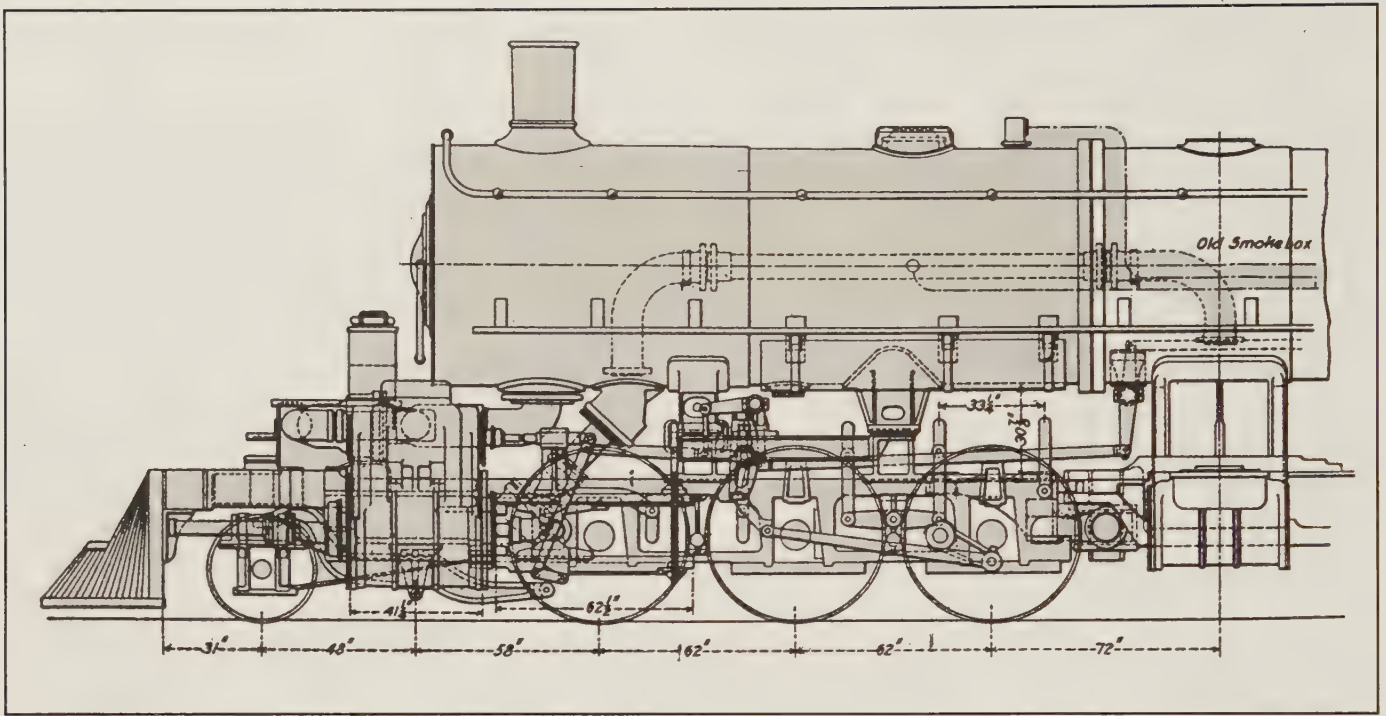
To obtain flexibility, both on curves and rough tracks, numerous approaches were taken including: equalizing systems; two, four and six wheel swing trucks, flexible beam trucks journal boxes with extraordinary side play tires without flanges (blind drivers) were improved forms giving to greater flexibility of articulated engines

Annatole Mallet, a Frenchman, built the first articulated locomotive in 1888. In his design, he implemented a number of innovations that converted the articulated locomotive from a visionary scheme to a practical achievement. Instead of allowing the rear driving wheels to swing about a center pivot, he secured them laterally in line with the

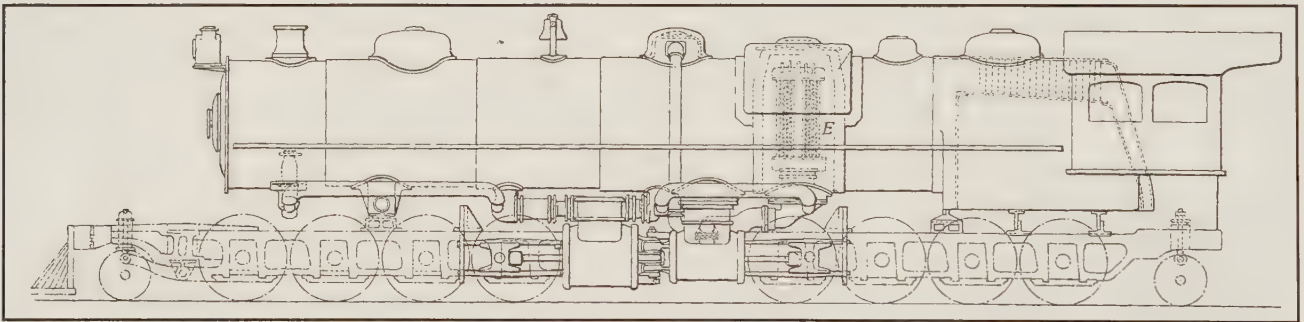
center pivot, he secured them laterally in line with the



In 1907 Baldwin introduced a front (tractor) engine and boiler unit for conversion of standard 2-8-2 and 2-8-0 locomotives into articulated locomotives.



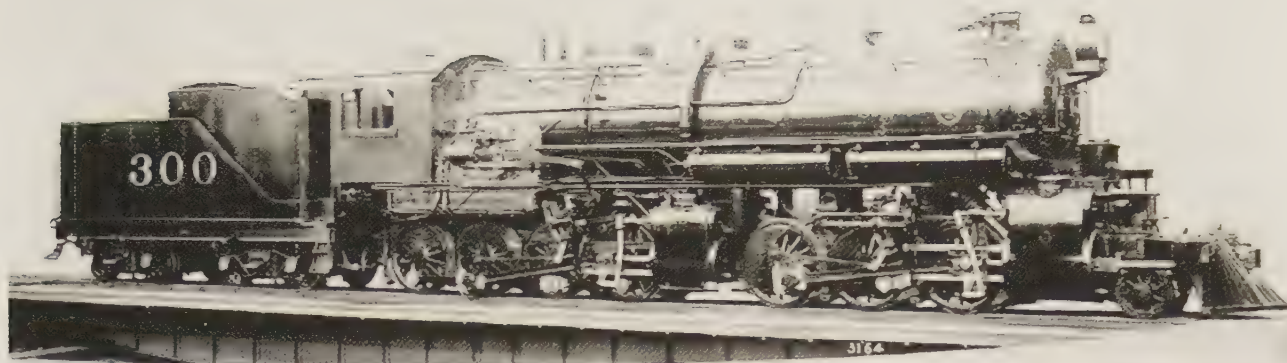
The 2-6-X-X tractor unit offered by Baldwin in 1907 for installation on a 2-8-0, turning it into a 2-6-8-0. The Great Northern purchased several and modified locomotives in their shops that year and during early 1908 before placing an order for more 2-6-6-2s. The Santa Fe purchased several 2-10-X-X tractors in 1910 to convert several 2-10-2s into 2-10-10-2. This modification was not popular at the time.



Baldwin Locomotive Works rapidly embraced the mallet-articulated locomotive technology. It developed its own style of superheater and proposed applications at the boiler just ahead of the fire box and also in the smoke box. This is Patent 952,909, dated March 22, 1910 by John W. Kendrick. It shows the superheater ahead of the fire box and immediately connecting to the high pressure piston, a reverse low pressure piston located in the reverse position. The patent application was made October 23, 1908, two years before the first 2-8-8-2 locomotive was built. This specific design was never built.

boiler. This allowed him to permanently attach the cylinders to the boiler, avoiding the use of high pressure flexible steam pipes, avoiding the leakage problems in the Fairlie design. The actual frame

carrying the forward driving wheels pivoted, avoiding the lack of boiler stability on curves. Baldwin pointed out that subject to their limitations, simplest devices are best, and that axiom is certainly true with



Alabama Great Southern, Number 300 c/n 33867 23&35x32 56" drivers, 2-6-8-0 built 10/1909. Baldwin produced an order for 35 more of this unusual wheel arrangement between 1909 and early 1912 for the Great Northern. It was not a popular wheel arrangement and was not duplicated.

tion was essential and simplicity had to be sacrificed to secure a satisfactory design.

Restricting conditions on locomotive design included stability of road bed, weight of rails, grades, curves, speed required, amount of load to be hauled, gauge of track, and the limits of height and width through which a train must pass. Modern ideas of economical railroad operation also demanded the use of the fewest number of trains to handle the traffic. The weight of trains on almost all roads was limited by the hauling capacity of locomotives, which in turn was limited by the conditions just named.

Additional horsepower theoretically required additional heating surface and grate area. This in turn required larger boilers. On standard gauge railroads, maximum boiler diameter was limited to around 7 feet by the gauge and other clearance requirements. Given that this diameter had already been reached, additional boiler capacity was accomplished by increasing the length of the boiler. The heaviest rigid frame locomotives in 1908 were the Santa Fe 2-10-2 type locomotives with a total weight of 287,000 pounds with 234,000 pounds over the driving wheels.

Baldwin pointed to its production of 150 2-10-2 locomotives for the Atchison Topeka & Santa Fe as a case for purchasing the articulated locomotive. While these engines were successful, they had a rigid wheelbase of 19 feet six inches. In comparison, a Mallet with six pair of driving wheels yielded in-

creased tractive power, but had a rigid wheelbase of only 10 feet, gaining an advantage allowing them to take curves more easily. Baldwin felt that while the Santa Fe locomotives were successful, they were approaching a practical size limit for rigid frame locomotives. With ever increasing demands for more pulling capacity, the Mallet appeared to have been most suitable to meet this need.

In November, 1904 Baldwin delivered its first three meter gauge Mallet locomotive to the American Railroad of Puerto Rico, 0-6-6-0. These engines carried 106,000 pounds on their driving wheels. One additional locomotive was delivered in January 1905.

Baldwin then turned their attention to helping the Great Northern and Northern Pacific solve their engine congestion problems in the mountain districts. Five 2-6-6-2 Mallets were ordered by the railroad and delivered by Baldwin in 1906. The engines were used as pusher engines on grades as steep as 2.5% while negotiating curves of ten degrees between Leavenworth and the Cascade Tunnel. Baldwin added the leading and trailing two wheel trucks to cut down on flange wear through the curves. The engines had a total weight of 355,000 pounds, carrying 316,000 pounds on their driving wheels. Assisting a Consolidation locomotive, these engines pushed loads averaging a whopping 1200 tons. Including the two engines and tenders the load was 1614 tons with an estimated 65% being carried

Baldwin's Introduction of Articulated Locomotives by Wheel Arrangement

0-6-6-0 November 1904
2-6-6-2 March 1906
2-6-X-X December 1907 (tractor extension for conversion of 2-8-0 to 2-6-8-0)
2-8-8-2 April 1909
2-4-4-2 June 1909
4-4-6-2 August 1909
2-6-8-0 October 1909 (Locomotive)
2-8-8-2 Cab-Forward November 1909
2-10-X-X 1910 (tractor extension for conversion of 2-10-2 to 2-10-10-2)
2-6-6-0 October 1910
2-6-6-2 Cab-Forward July 1911
0-8-8-0 April 1912
2-8-8-0 July 1912
2-8-8-8-2 April 1914
0-4-4-0 March 1915
2-8-8-8-4 November 1916
4-8-8-2 Cab forward July 1928
2-8-8-4 April 1930
2-6-6-4 1934
4-6-6-4 1938

by the Mallets.

In addition to solving the congestion problem the Mallets were promoted as fuel efficient, reducing the amount of fuel used per ton mile by 46%.

These locomotives proved so successful that the Great Northern ordered an additional 25 Mallets for use in road work between Leavenworth and Spokane, a distance of 197 miles.

The articulated locomotive was aggressively pursued and marketed by Baldwin. It, in many ways was a foretelling of future events for the railroads and locomotive builders.

The Great Northern 2-6-6-2s were the heaviest locomotive built by Baldwin as of 1906. They included the unique Belpaire boiler with 55 inch drivers and offered a tractive force of 64,700 pounds.

Introduction of Baldwin's Early Articulated Locomotives

The successful introduction of the hinged frame locomotive was a boon for Baldwin. The creative juices were flowing in the engineering department. For the railroads it meant that larger locomotives

with the hinged (articulated) frames could traverse more tight clearance or weight restricted trackage with less locomotives and larger trains. It had become a foregone conclusion that railroads would be better off if instead of ordering longer rigid frame locomotives, such as the 2-10-2, they could have more power with a 2-6-6-2 and better weight distribution. Thus the need for expanding Eddystone was quickly justified. The sales force hustled and orders for articulated locomotive poured in, putting American Locomotive at a disadvantage over an entirely new design of locomotive.

From 1904 until 1906, there was almost no serious activity in the new mallet-articulated locomotive product line. After Great Northern's initial order and the satisfactory performance reports, Sales rapidly picked up.

Baldwin's newest product line drug along with no serious sales in 1905, with just two articulateds sold. Even the five GN 2-6-6-2s in 1906 did little to stimulate sales. The year 1907 saw 41 locomotives ordered. It was only after the Great Northern and the order for the first Northern Pacific order for 2-6-6-2s, did interest take hold. Baldwin engineers

began to address what they felt would be a viable option for the many 2-8-0s then in service, by producing a tractor add-on unit, thus changing the 2-8-0 into a 2-6-8-0. The unit could be installed in most railroad back shops. The new front section became an extended smoke box and a re-heater. The Great Northern, well pleased with the second order of 2-6-6-2s purchased several add-on tractors to create the new wheel arrangement of 2-6-8-0.

The years of 1908 and 1909 saw 42 and 43 articulated locomotives coming out of the plant, all being assembled at Eddystone. Baldwin also entered four new wheel arrangements starting in April 1909 with the 2-8-8-2, a full year ahead of American Locomotive. June saw the diminutive 2-4-4-2 wheel arrangement, then in August the 4-4-6-2 and in October the 2-6-8-0 as an entirely new locomotive.

Introduction of the Cab-Forward Design

The first conventional 2-8-8-2 to roll out the doors of Eddystone was Southern Pacific Number 4000, c/n 33340, April 1909. A companion locomotive Number 4001 c/n 33341 followed. These two locomotives were taken west and put into service on the Sacramento Division of the Southern Pacific between Roseville, California and Sparks, Nevada, a line of heavy grades through the Sierra-Nevada Mountains. Heavy articulated locomotives were an absolute must on this line.

On trial runs with these locomotives, two prob-

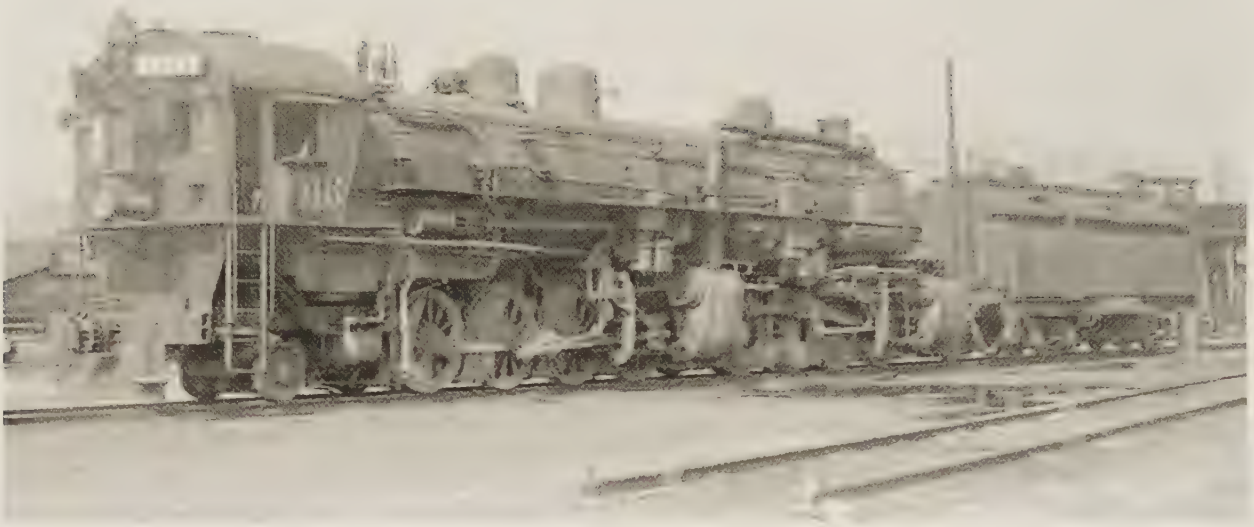
lems became evident. The great volume of exhaust gasses almost asphyxiated the crew in the tunnels and many miles of snow sheds. The stack exhaust velocity was so great that it blew the roof boards off of the numerous snow sheds. The locomotives were successful but the problem of crew exposure to toxic gases required some serious attention.

Legend has it that shortly after delivery of the 4000 and 4001 an enterprising engineer decided he was not going to be asphyxiated or expose himself to the tremendous heat and noise in the conventional cab. The engine was turned, and coupled, engine pilot to the train. The train, was operated through the Sierra-Nevadas, locomotive-backward, pulling the train behind. This alleviated the toxic gas and heat exposure. It created a few other minor problems such as pushing the tender ahead of the engine and the engineer being on wrong side for the signals. Other engineers began following this example.

Southern Pacific designers came up with a design to modify their new mallet-articulateds placing the cab in front. The SP had already placed an order for an additional 15 2-8-8-2s with Baldwin when the plans were drawn for the Cab-Forward. Those plans were immediately sent to Baldwin. In this radical redesign, the tender was attached at the smoke box end, the locomotive was turned so that the cab sat at the front end of the locomotive and the fuel oil was piped the length of the engine at 5 pounds pressure from the tender to the firebox, now located at the far end of the locomotive boiler. The oil bunker in the tender on these locomotives was made airtight and was structurally braced. They were slightly



Baldwin's first 2-8-8-2 articulated, Southern Pacific Number 4000, c/n 33340 April 1909. It had 57 inch drivers and tractive effort of 85,040 pounds. The boiler carried 200 psi of steam and the locomotive burned oil. The tender is of a normal rectangular box design. By late 1909 it had been converted to the Cab-Forward design.



Southern Pacific Cab-Forward 2-8-8-2 Number 4016, c/n 34097, built December 1909, was in the first batch of Cab-Forwards to come from Baldwin's new Eddystone plant.

pressurized with air to insure a constant oil flow to the burner in the fire box. The engineer's and fireman's controls were shifted to opposite sides of the cab so that when run "backwards" the controls would be on the same side as conventional locomotives. The unobstructed view from the cab were advantageous and crew visibility was tremendous.

The first 2-8-8-2 Cab-Forward, Number 4002 c/n 34019 rolled out the doors of Eddystone in November 1909, c/n 34019. The complete order for Numbers 4002-4016 emerged from the erection shop in November and December 1909. The Cab-Forwards were a reality. It started a marriage between the Southern Pacific Railroad and Baldwin Locomotive Works that saw all this unique design locomotive.

In April and May 1911 came SP Numbers 4017 - 4028, also 2-8-8-2s. In July and August 1911 Baldwin rolled out the only 2-6-6-2 Cab-Forward, Numbered 4200 - 4211, a fleet of 12 locomotives destined for passenger service. They proved unstable at high speed and were rebuilt as 4-6-6-2 after a serious derailment.

In October 1912 Baldwin rolled out Cab-Forward Numbers 4029 - 4039. The design was relatively unchanged until 1928.

Baldwin's Hinged Boiler Design

Baldwin quickly realized that the advantages of mallet articulated locomotives with two engines under one boiler had a couple of draw-backs, chief among them, a longer boiler would not clear restricted clearances such as some curves with the parallel sidings, certain tunnels and a few bridges, especially those where a curve was involved. Samuel Vauclain took his add-one tractor theory in a slightly different direction, first concluding that a boiler flue length of greater than 22 feet would not yield addition heat, therefore it would be easy to create an accordion hinge about 24 feet from the front of the firebox tube-sheet, add a front tube sheet, a full hinge to the boiler shell, then make the front area into a reheater for steam being passed from the high pressure cylinder into the low pressure cylinder. It gave the articulated frames a fixed rigid



Baldwin's only batch of the 2-6-6-2 wheel arrangement articulated Cab-Forwards built for the Southern Pacific. These were built for passenger service during July and August 1911. This is SP Number 4207, c/n 36684, built in July 1911. It had larger 63 inch drivers, typical of locomotives used in passenger service. The boiler carried 200 psi of steam and the locomotive burned oil. The tender is of the whale-back design.

boiler section each and in theory helped the ride of the locomotive.

The flexible joint or accordion bellows consisted of fifty rings of high carbon steel, which were ten inches wide and formed with a slight set, so that when faced to one another forming a series of V-shaped joints. The rings have an outside diameter equal to the outside diameter of the boiler shell. The rings were riveted together, each plate progressively alternating the inner and outer edges to form a bellow's-shaped structure approximately forty-four and three-quarters inches in length when assembled. The bellows was bolted into place between the front and rear boiler sections. A large internal flue, or bell housing, approximately 44 inches in diameter, was mounted traverses in the flexible connection, to direct the flue gases to the front boiler section. The purpose of this bell-housing was to prevent ashes and cinders from lodging in the flexible joints.

The Santa Fe railroad purchased six 2-6-6-2 locomotives from Baldwin between June 1911 and December 1911, hoping they would ride more easily than the rigid locomotives they were intended to replace. Two had jointed boilers and four had flexible boilers with a large ball-joint type flue ring. They were not successful and went to the back shop for modification.

ATSF 1170 c/n 34862	6/1910
ATSF 1171 c/n 34863	6/1910
ATSF 3320 c/n 37345	12/1911

ATSF 3321 c/n 37346	12/1911
ATSF 3322 c/n 37347	12/1911
ATSF 3323 c/n 37348	12/1911

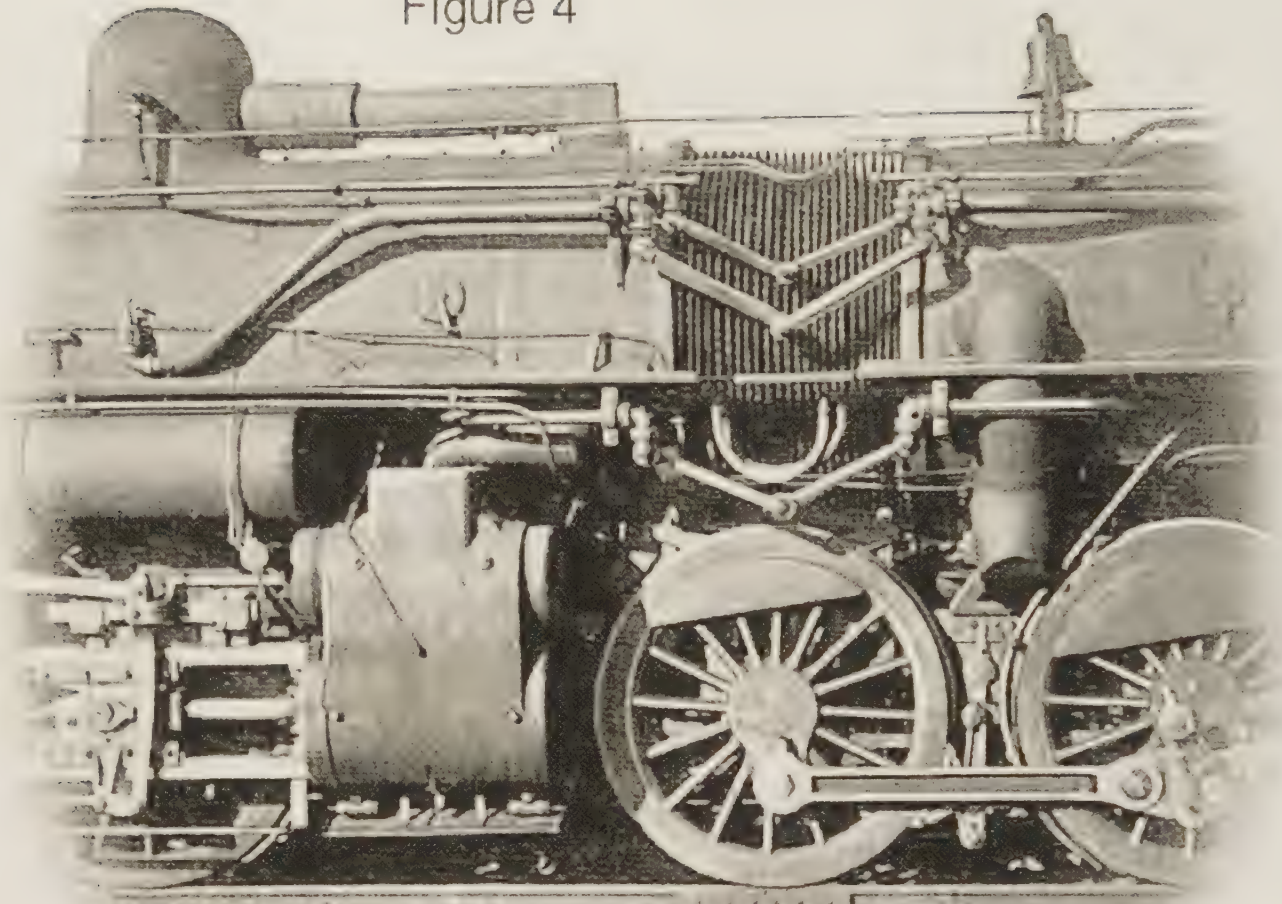
The High Water Mark

The year of 1910 was a high water mark year for Baldwin's articulated locomotive business. They put a whooping 152 locomotives on the books and began plans for expansion of the erecting shop at Eddystone. They also introduced a second add-on tractor, the 2-10-0, which would mount to the front of a 2-10-2, thus providing a 2-10-10-2 locomotive. Baldwin never built a new 2-10-10-2, but sold several tractor kits to the Atchison Topeka & Santa Fe Railroad for their locomotives.

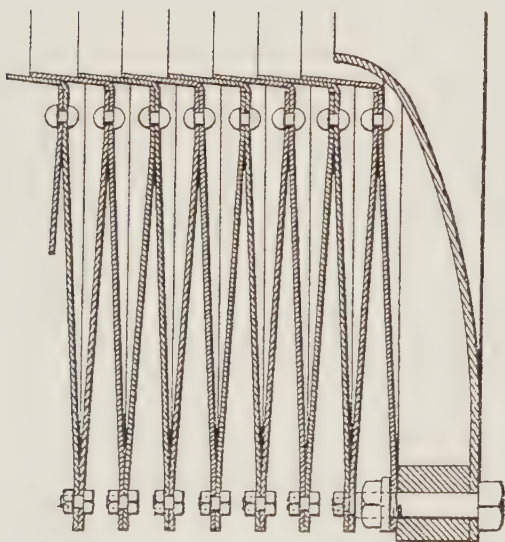
The years of 1911 and 1912 saw orders for 63 and 59 articulated locomotives. Five years behind American Locomotive Baldwin built its first 0-8-8-0, but beat American Locomotive by four years with the introduction of the 2-8-8-0.

The year of 1913 saw a low number of just 8 articulated locomotives on the books, followed by 71 in 1914. It was April 1914, that the Triplex or 2-8-8-8-2 was introduced. Baldwin consulting engineer George Henderson had filed it for patent June 12, 1911. Patent Number 1,013,771, dated January 2, 1912. When built, it was a record breaker and crowds gathered at Eddystone property gates to see this massive locomotive rolled out the doors. Two more were built in 1916. The next design added to the portfolio was the 2-8-8-8-4 for the

Figure 4



FLEXIBLE BOILER CONNECTION



Samuel Vauclain, and Burnham, Williams & Company, (Baldwin Locomotive Works) rapidly embraced the mallet-articulated locomotive technology. Vauclain took a keen interest in the concept of hinged boilers for articulated locomotives. The accordion bellows plate fabrication is illustrated. Note the hinge arrangements for the boilers in both locomotives. The idea was to allow longer boilers to swivel and thus be accommodated in tight clearances where the overhang of a larger and longer one piece boiler would have prohibited such locomotives. A version of Patent Number 912,923 was built and used on the locomotives of a few railroads. They were not well received in actual service.

Virginia Railway in November 1916

Orders for 1915 and 1916 amounted to 1001 and 20 units in the articulated product group. March 1915 saw the introduction of the 0-4-4-0, built almost exclusively for the meter gauge trench railroads of France during WW I.

The age of the articulated locomotive was over almost before it began. The year 1918 saw 59 articulated units ordered, and the era came to a roaring end in 1919 with 102 locomotives rolling out of Eddystone.

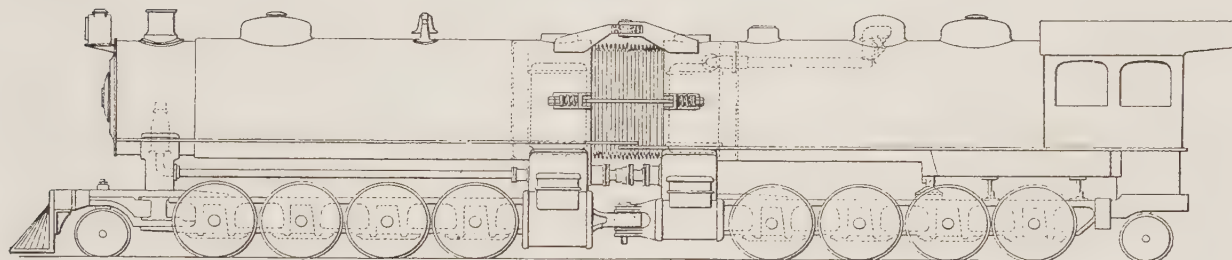
Between the years of 1920-1927 a total of 46 articulated locomotives were ordered.

The Triplex and Quadraplex Designs

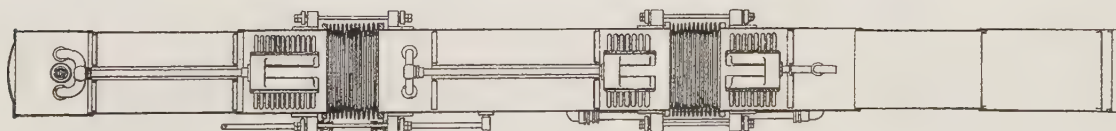
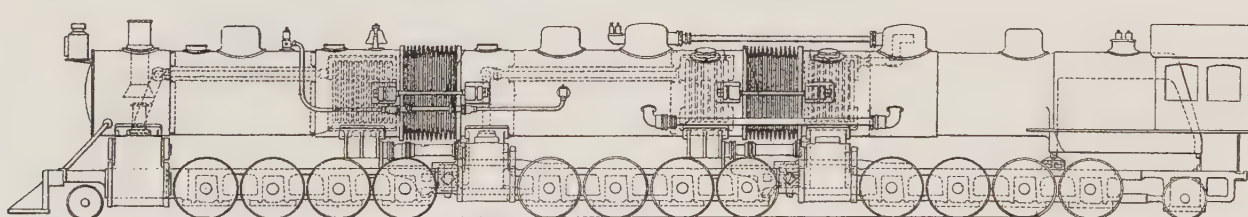
Consulting engineer, George Henderson, who worked closely on the articulated designs, used those mallet articulated locomotive designs and Vaucrain's recent patents for the flexible boiler locomotive to move into the next phase of new designs, that of the triplex locomotive.

The idea was to create a locomotive with a boiler extending over two engine drive frames and then an additional drive frame placed fully under the tender to create additional adhesion and traction. Henderson referred to it as the triple compound locomotive.

Not visible to the eye was steam flow, which made the locomotive unique. The four end cylinders were low pressure. They were piped to receive the exhaust steam from the high pressure cylinder so that



The Baldwin hinged boiler as illustrated in Patent 912,923, dated February 16, 1909. Samuel Vaucrain was the inventor. It has hinge members above the boiler shell in addition to those in the frame and was designed to carry separate boiler sections connected together by a hinged joint.



This is a double hinged boiler triplex, Patent 976,014 dated November 15, 1910. This was Samuel Vaucrain's first attempt at designing a triple expansion articulated locomotive, each section carried on a separate frame.

the exhaust from just one high pressure cylinder fed into two low pressure cylinders. The original triplex patent, Patent Number 1,013,771 offered the option of using the Baldwin flexible boiler or a standard rigid boiler. The front section of the rigid boiler held out the options of generating steam, partly superheating steam or for the heating of feed water.

Henderson described the triplex tender as a term applied to the locomotive, supported on an independent powered frame connected to the locomotive and having the usually water tank and fuel bunker, "the frame is sufficiently weighted to give the driving wheels the necessary adhesion."

The tender cylinder exhaust was to either be directly exhausted to the atmosphere or directed to heat tender water, or train heat for passenger train needs.

Finally, a sand box was located on the tender and the exhaust steam was used to heat the sand box so the tender drivers could have dry sand.

Baldwin went shopping for customers and the Erie Railroad placed an order for one rigid boiler 2-8-8-8-2 in 1913. It rolled out the doors of Eddystone in April 1914, wrapped in its Russian iron jacket, as crowds of onlookers watched it move about the growing complex under its own steam

during preliminary testing. Erie Number 2603, c/n 41308 named "Matt H. Shay" weighed in at a whopping 853,050 pounds and rode on 63 inch drivers. It was intended for use on Erie's Gulf Summit grade. It quickly ran out of steam and within a short time the original grate area of 90 square feet was rebuilt to a larger 122 square feet.

Two additional triplex locomotives were ordered by the Erie in 1915, Numbers 5015 and 5016 c/n 43351. They were delivered in May 1916 with the larger fireboxes and a heavier total weight of 860,350 pounds. They were placed in service on the Erie's Sesquahanna incline. All three locomotives were retired between 1927 and 1929.

One last triplex locomotive was built by Baldwin for the Virginian Railway, a 2-8-8-8-4 c/n 44448. It delivered in November, 1916 as VGN Number 700. It weighed in at 844,000 pounds but used smaller 56 inch diameter drivers.

This engine was placed in service on a difficult 14-mile section from Elmore to Clark's Gap, West Virginia. Even with a larger boiler and a higher operating pressure, it used a smaller 108 square foot grate area but there was still not enough steam. The locomotive was not successful and was returned to Baldwin in 1920 for conversion into a 2-8-8-0



Atchison, Topeka & Santa Fe Number 1169, flexible boiler 2-6-6-2 c/n 37347 built December 1911.



Atchison, Topeka & Santa Fe Number 1169, straight boiler 2-6-6-2 c/n 35730 built December 1910.

Number 610 c/n 55100 10/1921. The tender tractor unit had the tender tank removed and a boiler placed on it to form a 2-8-2 Number 410 c/n 55099 9/1921.

Of the four triplex locomotives built, none were used in regular long-distance freight service, all were kept near and used on helper districts. All suffered from undersized fire box and a large appetite for steam. Maintenance was higher due to the increased machinery. Baldwin never built a flexible boiler triplex and by the end of WW I the demand for such locomotives was past with the dawning of Super-Power and other locomotive improvements.

George Henderson did not stop with the triplex design. He was issued Patent Number 1,100,563 dated June 16, 1914. The application was filed December 11, 1913, for an even larger engine, the quadraplex. It was essentially two compound articulated locomotives under a flexible boiler and tender..

The idea was to create a multiple locomotive with two independent boiler sections heated from a single fire box. The steam from half, or one boiler, being used to drive one-half of the locomotive in compound mode only and steam from the other half being used for the other half of the locomotive. While the idea was amusing, it was not practical. The locomotive would have reduced operating crews required, but it gave the engineer two throttles, and two reverse levers to thus operate each half of the locomotive independently from the other or in unison. There was no common steam connection be-

tween the boilers, the only thing shared was hot flue gases. The front boiler was completely dependent on the flue gasses from the rear boiler for its heat. The patent mentions the front cab as optional, very much designed on the basis of the Southern Pacific Cab-forward cab. Such a shelter would give the engineer a continuous unobstructed view.

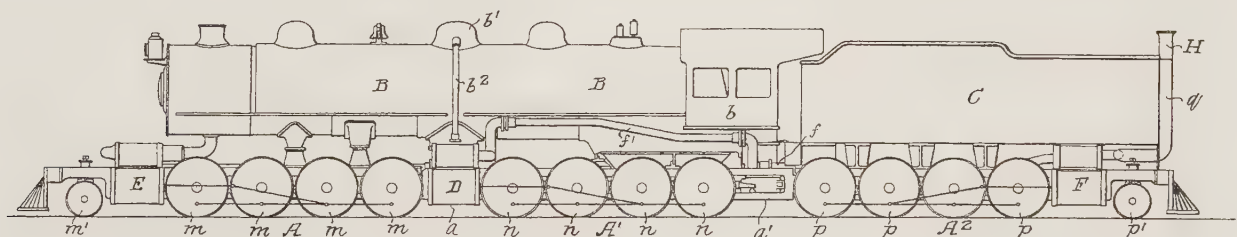
If built, with two cabs, the engineer and firemen would have communicated via speaking tubes and whistles. The firebox was designed, oddly similar to the Super-Power designs that became common after 1924. This locomotive was designed to have four articulated frames, three supporting the tandem boilers and one to support the tender. It was never built.

Baldwin's reason to build Eddystone died before the great Eddystone complex could be completed.

There was no further pick-up in articulated orders until 1938. The next peak year was 1942 when 85 articulated locomotives were ordered.

Samuel Vauclain's notion of what a steam railroad locomotive was about caused two strategic management decisions in the 1920 - 1930 era, first he thought that to get more work out of a locomotive meant bigger boilers, more drivers and more cylinders as with the articulated locomotive. That proved wrong and even close customer Pennsylvania Railroad did not buy into it. By that did not prevent Vauclain from directing Baldwin engineers to design even larger locomotives.

The railroads were loaded down with the USRA



The Triplex compound or 2-8-8-8-2 was introduced in 1914. Baldwin consulting engineer George Henderson had filed for this patent June 12, 1911. Patent Number 1,013,771, dated January 2, 1912. Note, the tender tractor cylinders are reversed in the patent application. The actual locomotive had them directly under the locomotive cab. The largest problem with this locomotive was a lack of steaming capacity and vast amounts of machinery.

The Triplex Locomotives



ERIE 2-8-8-2

c/n 41308 4-1914 #2603

c/n 43550 5-1916 #5015

c/n 43351 5-1916 #5016

Boiler pressure: 210 psi

HP cylinders: 36" diam x 32" stroke (two, in centre)

LP cylinders: 36" diam x 32" stroke (four, two each end)

Weight, total: 853,050 lbs/860,350 lbs

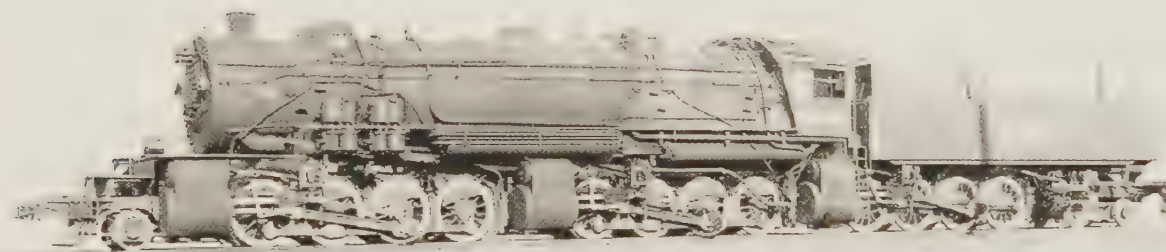
Wheel base, total 90' 0"

Boiler diameter: 94"

Tractive Effort: 160,000 lbs

Wheel diameter: 63"

Grate area: 90 sq ft /120sq ft



VIRGINIAN 2-8-8-4

c/n 44448 11-1916 #700

Boiler pressure: 215 psi

HP cylinders: 34" diam x 32" stroke (two, in centre)

LP cylinders: 34" diam x 32" stroke (four, two

each end)

Weight, total: 844,000 lbs

Boiler diameter: 100"

Tractive Effort: 146,000 lbs

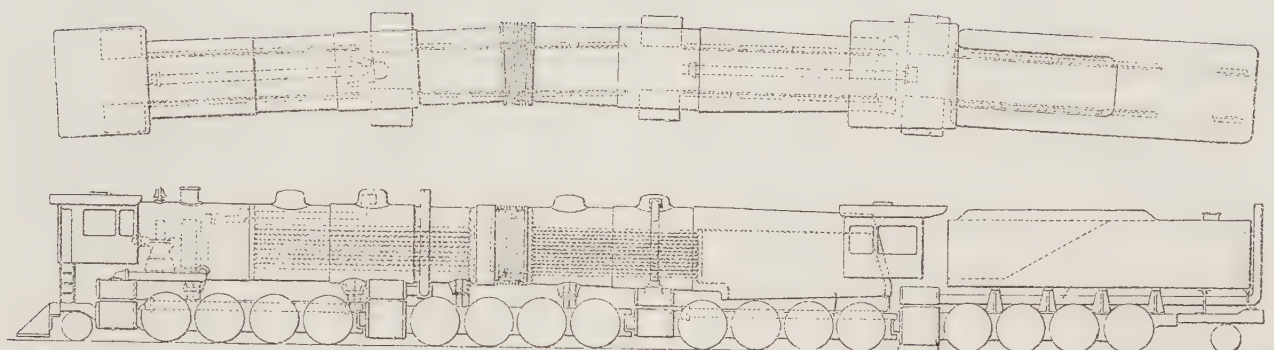
Wheel diameter: 56"

Grate area: 108 sq ft

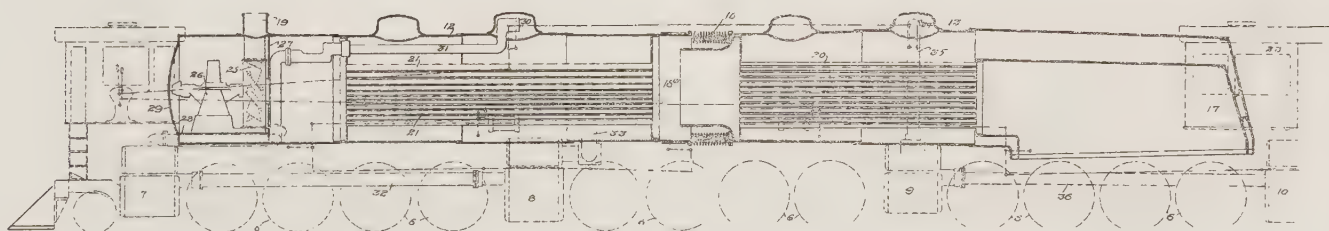
Wheel base, total: 91' 3"

After just four years of service this locomotive was returned to Baldwin in 1921 and greatly modified from its Triplex wheel arrangement into a 2-8-8-0 Number 610 c/n 55100 10/1921. The tender tractor unit had the tender tank removed and a boiler placed on it to form a 2-8-2 Number 410 c/n 55099 9/1921.

The Baldwin Quadraplex Compound Articulated Locomotive



This is the Baldwin quadraplex cab-forward design. George Henderson Patent Number 1,100,563 dated June 16, 1914. The application was filed December 11, 1913. The object of this invention was to create a locomotive with two independent boiler sections, the steam from half being used to drive one-half of the locomotive in compound mode only. It also gave the engineer two throttles, and two reverse levers to thus operate each half of the locomotive independently from the other or in unison. There was no common steam connection between the boilers. The front half was completely dependent on the flue gasses from the rear boiler for its heat. The patent mentions the front cab as optional, but such a shelter would give the engineer a continuous unobstructed view. If built, the engineer and firemen would have communicated via speaking tubes and whistles. The firebox was designed, oddly similar to the Super-Power designs that became common after 1924. This locomotive was designed to have four articulated frames, three supporting the tandem boilers and one to support the tender.

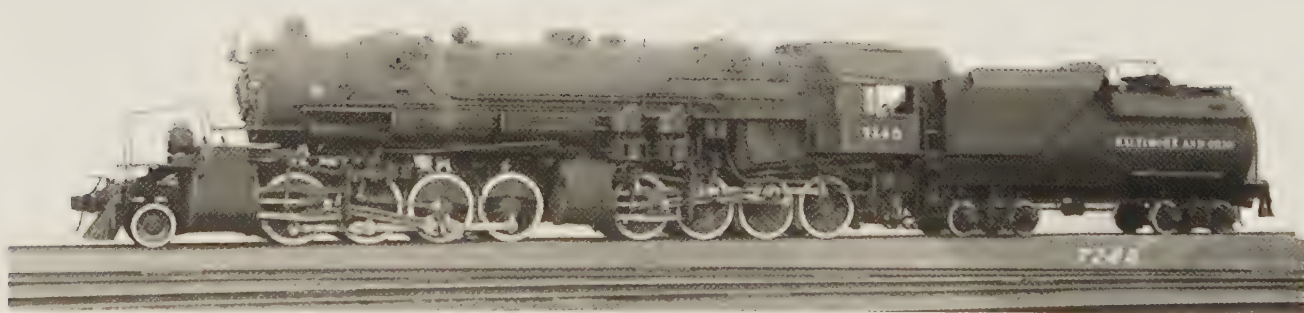


This is a broadside cutaway drawing from Patent Number 1,100,563, which shows details of the main boiler, the flexible joint, the secondary front boiler, smokebox and motor driven blower and the two locomotive cabs. On the left in a cab-forward position is the engineers cab. At the firebox end is the firemen's cab. Details of the boiler flex-joint are evident in this drawing. Note the flue gasses are funneled through a bell-housing and into a smoke space then pass into a second set of flues drawn by the blower. The flexible accordion skin at the flexible joint did little more than make the boiler flexible, it did not hold any pressure.

fleet from WW I and a lack of traffic to provide a strong incentive to go after more heavy power. With the introduction of competitive Super-Power in 1924, railroads could get more work out of the same pound of coal and the focus went quickly toward that advance in locomotive technology.

With the failure of the Baldwin Number 60000, the focus went back to an articulated design employing many of the innovations of Super-Power. Baldwin engineers agreed that with a boiler design able to produce more steam than the boiler could use, would bring a practical application to an improved articulated locomotive.

Other significant design advances in steam locomotive that were on the drawing boards as early as 1918 did much to displace the need to built significant numbers ofallet articulated steam locomotives after WW I.



Between February 1916, and December 1919, the Baltimore & Ohio Railroad contracted with Baldwin to produce 71 massive 2-8-8-0s at its new Eddystone Works. The first, Number 7100, c/n 42832 was delivered in February 1916 amid much local press and fanfare. Crowds gathered around the gates on Chester Pike to see these massive locomotives. Pictured here is Number 7145, c/n 52371, delivered in September 1919. The last of the group, Number 7170 was delivered in December 1919, even though it was not a USRA design locomotive.

From Pasture Land to Munitions Plants at Eddystone

It was not the increased demand for locomotives that grew the Eddystone property into a major industrial complex, but rather the production of military crawler tractors, artillery shell forgings, rifles and eventually ammunition production. Customers for these items were the governments of Czarist Russia, France and Great Britain, then in 1917 for the United States.

When the First World War broke out in August 1914, Baldwin's two Philadelphia locomotive plants were operating at only about one-third of capacity. Locomotive orders for 1913 were a very good 2,061, with dramatic downward shifts to 804 locomotives in 1914 and some lay-offs. The one erecting shop at Eddystone was not overly busy and at times worked only two or three days a week until the end of the third quarter of that year. Much of the 184 acres of property remained undeveloped marsh and prairie.

When officials of The Baldwin Locomotive Works recognized the significance of the European conflict they were sought out by others for the manufacturing of munitions. In early 1915 the surplus manufacturing capacity of the Company was placed at the disposal of the Allied Governments; United States, Great Britain, France and Czarist Russia. The sleepy village of Eddystone would soon come into the global spotlight as a defense and heavy metal manufacturing center, the likes of which had never before been witnessed on earth.

The pressing needs for ordnance, ammunition and other supplies by the allies were such that all efforts in these early days of the war were directed towards the development and production of armament and munitions by neutral countries. In Czarist Russia, greater distances and a desperate shortage of motive power and equipment necessitated the purchase of hundreds of loco-

motives for main line railroads as well as narrow gauge trench supply railroads. In France and Great Britain there was a crucial need for main line locomotives and for narrow gauge trench locomotives to supply the European battle front.

The demand for locomotives for military service abroad, along with improvement in domestic locomotive orders, placed the Works on a full capacity basis by early 1916. In a joint statement, March 23, 1916, combined employment for the Remington Arms Company, Eddystone Ammunition Corporation and The Baldwin Locomotive Works was 31,000. Another 10,000 were being sought to start within 60 days. During this same period orders were received from the British and French Governments for the machining of a large number of artillery shells, varying in caliber from four and seven-tenths inches to twelve inches and an even larger number of shell forgings.

Baldwin manufactured ordnance components at two separate sites during the Great War. Shell forgings, their initial wartime product were manufactured in much of the existing locomotive shops at Broad Street. Plus a new eight-story building that was constructed at 19th Street and Noble. This was on the west end of the Broad Street plant and it was specified to handle munitions work. A July 21, 1916, news article detailed 320,000 feet of floor space in the building that cost \$800,000 to build and another \$1,500,000 for tooling. Daily, over 1,000 men in the construction trades were involved in its construction.

The first ordnance produced at Eddystone were in shops specially built and equipped for complete finishing and packing work of the ammunition. A group of large shops one story in height, was built east of the black smiths shops and utilized for the completion of a shell order from the French Government. These were fully

packed 8 inch shells, for which the first shipments left on June 16, 1916. With the acquisition of a \$40 million dollar Russian shrapnel contract for 2,500,000 3 inch shrapnel shells, significant additional buildings were put under construction. Early 1916 brought several additional orders including a contract from the United State Army for 3,500,000 shells and 17,000,000 shell forgings, plus significant work as a subcontractor for Midvale Steel and Ordnance in the production of shell forgings and their machining. Baldwin itself held contracts for \$26 million dollars of war materials and equipment at the end of December 1915.

Baldwin entered into several joint ventures with allied suppliers including Midvale Steel and Ordnance, a recently purchased Baldwin subsidiary in Philadelphia, and producer of armor plate, rifle steel, railway axles, driver tires and forgings, Hercules Powder for the ammunition powder used in the shells, American Bridge for some special structural frames, Remington Arms for rifles manufacturing expertise, Southwark Foundry and Machine and others.

Remington Arms Company of Delaware was the first to enter into a contract for construction of new facilities at Eddystone for the manufacture of rifles. This in turn allowed Baldwin to construct

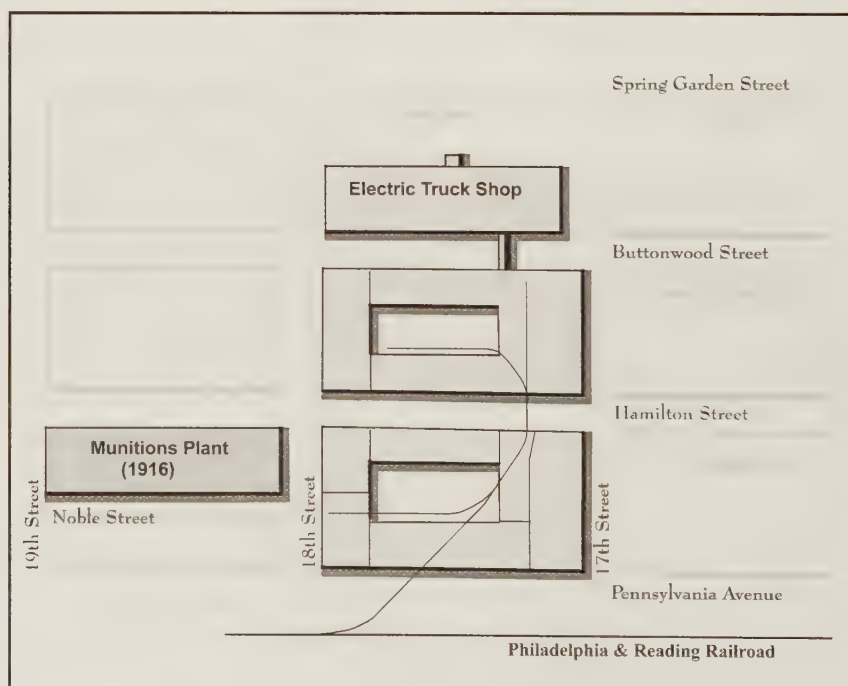
another building at Eddystone with a tenant. Under the terms of the contract, Baldwin would construct the buildings and lease them to Remington. They would also receive a portion of the profits on each rifle, bullet and shell produced in the facility. At the end of the contract the facilities would become available to Baldwin for eventual use in manufacturing locomotives.

Remington-Eddystone Arsenal

On April 30, 1915, the British Government placed a contract with the Remington Arms Company of Delaware for 1,500,000 rifles to be manufactured in a massive new factory building to be built at the Eddystone property by The Baldwin Locomotive Works. It put 20 acres under roof with three floors (60 acres) of manufacturing space plus support buildings.

The Remington Arms Company of Ilion, New York, was a manufacturer of hunting rifles. This was its first significant military weapons contract. The firm, owned by Marcellus H. Dodge, entered into a partnership arrangement with Midvale Steel and Ordnance, itself a newly acquired Baldwin subsidiary. The new firm would be called Remington Arms Company of Delaware. The Bald-

Not all of Baldwin's defense plants were built at Eddystone. In 1916 an eight story building with 320,000 square feet of floor space was constructed at the Broad Street plant in Philadelphia, along with a four story plant to assemble electric trucks for the interurban and electric railway industry. One wonders why these expenditures were made at a time when it was known that Broad Street would be closed.



win Locomotive Works constructed the plant and leased it back. Midvale Steel supplied the rifle steel while Remington Arms of New York supplied the management expertise. The plant tooling, estimated at \$2 million, was paid for by the British Government. This was a tremendous undertaking at the time. A level of construction and tooling never before heard of suddenly enveloped the borough of Eddystone. At the time of its construction Baldwin officials were considering whether to later turn it into a tractor manufacturing plant or a boiler shop for the forming and assembly of locomotive boilers after the war.

Three major buildings were built for the manufacture and testing of the rifles. Two small indoor rifle ranges were built east of the main building. The main building of the Rifle Plant had a length of 1,040 feet and a maximum width of 816 feet. It was built along Simpson Street in Eddystone. The plant experienced great difficulty in obtaining delivery of suitable manufacturing equipment and machinery in a timely fashion to meet the terms of the British contract. Experienced machinists were in high demand and shortly the small borough of Eddystone found itself thrust into a difficult position of being too small to supply the housing, and infrastructure needs of the new residents.

Some idea of the extent of the installation may be had from the fact that ten thousand machines were initially required. Opposed to Samuel Vauclain's idea that the plant should be powered with electric motors, some 42,200 feet of line shafting, and 424,000 feet of belting were required to establish sufficient machinery drives in

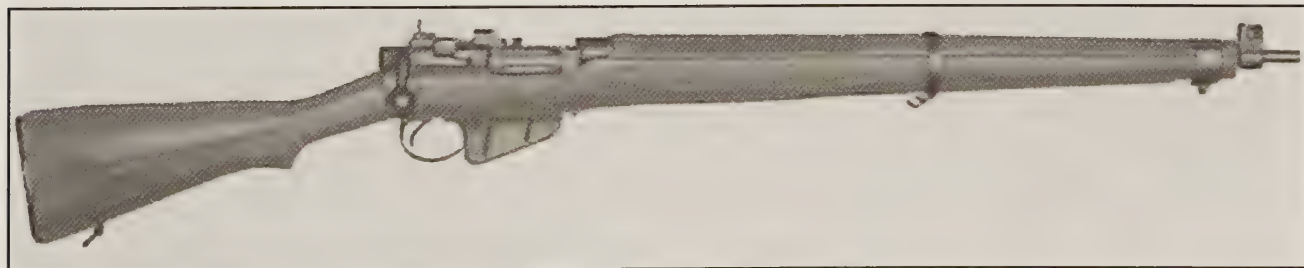
the facility in lieu of electric motors for each machine.

John T. Thompson*, from the U. S. Army's Ordnance Department, retired first from the Army in 1914. He went to work for the Remington Arms Corporation, and in 1915 was assigned the task of managing installation of the worlds largest rifle factory at Eddystone Pennsylvania. The 34 acres of factories was built to support the War effort in Europe. Estimates of production proposed to produce rifles at the rate of 6,000 a day. The rifles initially produced at Eddystone were the .303 Lee-Enfield for the British Army, and a bit later a contract for 2,000,000 of the 7.62 Mosin-Nagant rifles for the Russian army.

The work of constructing, equipping and organizing this enormous plant was a major mark of logistics and cooperation and took on a world focus. Initially 4,000 machines had to be built, set into a plant that itself was under construction and tested within six months. Hundreds of thousands of terra cotta tile used for the walls and roof were manufactured on site at a plant erected by O. W. Ketcham. The clay and sand was transported to his plant on the western end of the Baldwin property, where it was blended and formed into the hollow core tile then baked in large kilns.

Remington quickly realized there was not enough available skilled labor to run the machines. Recruiting was started on a national basis with a target of 20,000 men. Recruiters brought

* John T. Thompson, a native of Newport, Kentucky, was the future inventor of the Thompson Sub-machine gun or "Tommy Gun." He termed it an automatic rifle.



The Lee-Enfield Pattern 14 Rifle (the P14 Enfield) of the British Government. About 1,500,000 of these military rifles were manufactured at Eddystone in a building specially constructed for the mass-production of this weapon. After the end of WW I the building became the boiler shop for The Baldwin Locomotive Works.

men in from as far west as Iowa and anywhere in the south and north that skilled workers could be recruited. Starting wages of \$3.75 to \$4.00 a day for skilled mechanics were offered as an incentive. Some desired employees were held on retainer of \$.50 a day guarantee until summoned to Eddystone. Common laborers were started at \$.90 per day.

In the Borough of Eddystone, a quaint river community, there suddenly was not nearly enough available housing to accommodate the workers. Workers were forced to find housing in both the Philadelphia area as well as across the state line in Delaware to the south and also in communities west of Eddystone. Remington made housing guarantees and many boarding houses and apartments were constructed in the Boroughs of Eddystone, Crum Lynn and Chester in what became a real estate investors dream market. Real estate speculation and a building boom took place beginning in 1916, the likes of which were never before seen and would not be repeated until construction of Hoover Dam twenty years later. Hundreds of men lived distant to the plant, taking rooms wherever available and commuting to work by train or trolley. The Baldwin Locomotive Works took full advantage of available real estate

* Midvale Steel's two steel plants was sold to Bethlehem Steel Corporation in 1923. Midvale Steel and Ordnance was retained by The Baldwin Locomotive Works.

for future industrial development, purchasing 100 acres of property on the Delaware River, north of their original acquisition from the Estate of William Simpson and Joseph H. Ward on February 4, 1916 (This site was later filled and in the late 1920's became the site for construction the massive General Steel Castings Corporation, a steel foundry which Baldwin held a significant interest.) Seventy-one acres were purchased from Clarence Deshong on July 14, 1916, near the northwest edge of the smith's shops and up to the Pennsylvania Railroad. This included the site of a formerly popular horse race track.

The Pennsylvania Railroad recognized new commuter business as the munitions plants were put under construction and established the new station of North Eddystone in the middle of the growing Baldwin complex. The new stop was established in October 1915, on the main line as a planned commuter terminal to bring workers in daily from the Philadelphia area. Most of the employees were required to live away from the plant. The stop was later renamed Baldwin. They also laid a fifth main track to accommodate the increase in commuter train traffic and several side tracks to accommodate the trains off the very busy main tracks. The first dedicated Philadelphia-Baldwin commuter trains operated on April 26, 1916. The Pennsy further established a commuter run on its Chester Creek Branch to



The Remington Arms Company of Delaware building looking north along Simpson Street in Eddystone, Pennsylvania, during construction in 1915. The Lee-Enfield rifle was manufactured here for use in WW I. Note the board fence along the street. After the war the building was used for storage until 1926, when it was transformed into the boiler shop for The Baldwin Locomotive Works. The power house and maintenance shop on the right were originally built to test fire the rifles. -- BLW Photo

gather employees from the small towns enroute, and expanded the size of its Eddystone passenger station to accommodate the daily influx of workers. The Reading built a new passenger station at the same time, opening in April 1916. The Philadelphia Rapid Transit (street railway) added an average of 41 trippers to transport workers from 13th and Market Streets in Philadelphia out to the plant. The Southern Pennsylvania Traction Company achieved a franchise to extend their line into Eddystone on 9th Street and up to the Baldwin industrial sites on Simpson Street in an effort to capitalize on the growing transportation market. The line was completed by August 1916 with a double track on Simpson to accommodate the many cars required to transport workers to and from the plants.

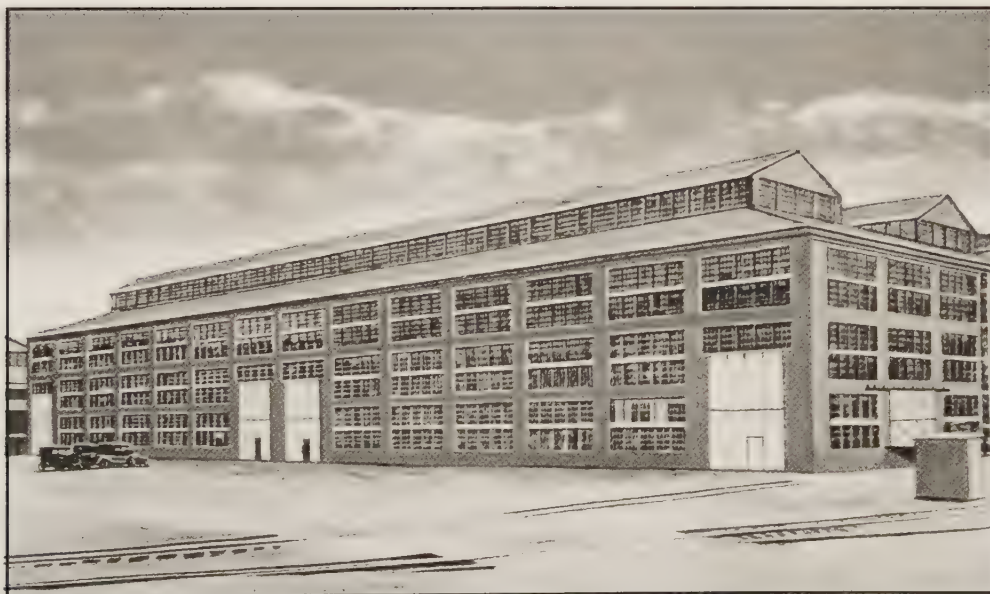
The inn keepers and few small restaurant owners at Eddystone were totally ill-equipped to feed the thousands of men who suddenly appeared in the community to work. Cafeterias were added inside the Remington, Baldwin and Eddystone Ammunition plants, but even that was not enough to feed the thousands of employees. In February 1916, the caterer reported coffee

sales alone required one ton of coffee, two tons of sugar and 15,000 quarts of milk. Coffee was sold to the men for two cents a cup and it was always ready and waiting their arrival at the plants. Meals were sold to first and second shift workers and given as a shift bonus to those who worked the third trick. Meal break was just twenty minutes.

By December 11, 1915, 3,500 men were employed at the unfinished Remington Arms plant, installing machines. The plant was still under construction by scores of construction workers. As quickly as an area could be put under roof, the mechanics brought in and setup machinery.

About 1,500 manufacturing employees were brought in December 15, 1915, to start production of rifles and continued until its close in December 1918. The first 1,500 British rifles were sent to England in March 1916, for final approval as several thousand awaited authorization for shipment.

The Lee-Enfield rifle, the initial item of manufacture at Eddystone, was first introduced in 1895, as the main military service rifle of the British Empire and her Commonwealth countries. This rifle was known as the Short Magazine Lee-



This 1916 post card marked, "Main building Remington Arms Co., Eddystone, Pa., near Chester." This is the west end of the three story building where rifles for WW I were first manufactured. After the war the building was used for storage until 1926, when it was transformed into the boiler shop for The Baldwin Locomotive Works. -- *Author's collection*

Enfield.

The rifle was designed by James Paris Lee, a Scottish born firearms designer who worked chiefly in the United States and Canada. His design incorporated a “cock-on-closing” bolt with rear locking lugs and a detachable 10 round magazine. This action was combined with Enfield rifling to create the Lee-Enfield.

The rear locking lugs allowed a bolt movement of the same length as the cartridge and the design of the locking surfaces gave a particularly easy movement to the bolt handle. These features combined, made the Lee Enfield the fastest and lightest rifle to manipulate. Aimed fire could be undertaken at up to 15 rounds a minute without much fatigue to the trained soldier. Other major benefits included the detachable bolt head which could be threaded off and changed to compensate for varying head space and the large 10 round magazine, twice the capacity of the other military rifles of the time. The Lee-Enfield was an exceptionally good combat rifle, and its robust construction permitted operation in the extreme conditions of the battlefield.

The Lee-Enfield gun system had two flaws, and one was its cartridge. The .303 was a rimmed cartridge and it was prone to jamming. To avoid this problem, the rounds had to be carefully loaded with the rims lying in exactly the right place both when loading individual rounds into the magazine and also onto the charger clips. The British government did not want to incur the cost of replacing its stockpile of .303 rimmed cartridge with the more reliable rimless cartridge. Its intensive machining requirements resulted in slow production.

With John Thompson reactivated into the Army, Charles H. Schlacks was hired as General Manager for the Eddystone Rifle Plant on May 1, 1915, and to him fell the completion of the organization and the manufacturing results obtained.

The first British contract was followed by another, signed August 2, 1915. It called for an additional 500,000 rifles, and necessitated additional equipment to be installed in the plant. By

December planners were calling for 8,000 additional machines to manufacture the rifles. Because of the complexity of rifle manufacturing, it was nearly impossible to obtain experienced workmen; hence it was some time after the completion of the plant before it could be operated at capacity and delivery dates were missed.

Production started in January 1916, but ran at an irregular pace according to newspaper accounts due largely to the difficulty in obtaining both machinery and skilled mechanics.

By early 1916 Remington Arms of Delaware had not been able to maintain its production commitments and was near default. Midvale Steel and Ordnance, the parent company acquired the contracts from Dodge for a reported \$24 million. They continued with the British and Russian contracts, held harmless for any losses on completion of the original contracts.

The United States entered the war April 6, 1917, and in view of anticipated United States rifle requirements, cancellation of the British contracts was executed, after the completion of 600,000 rifles. The British owned machinery and equipment was purchased for \$900,000 by agreement.

While awaiting the rifle contract, Vauclain and others had the plant machinery retooled for the newly developed .30-06 rifle. They immediately commenced production of “spare parts.” The United States Government continued the manufacturing arrangement with the Remington Arms Company, a division of Midvale Steel and Ordnance for the manufacture of rifles for the United States Army.

The first contract for rifles for the United States Government was signed on July 12, 1917. The next day the first completed rifle was handed to the Secretary of War for his acceptance. Within eight days full production was underway. During the twelve months beginning September 1917, 1,000,000 rifles were completed, the greatest known achievement in rifle production. The former production had been for the Mauser-style Enfield rifle designed by the British in the early

1900s, they were chambered in .303 for rimmed cartridges. With the United State entered the Great War the government decided to produce .30-06 version of the P-14 Enfield, using the rimless cartridge. The rifle was designated "Model of 1917."

The change caused a retooling of the plant to be immediately undertaken for the firing of the rimless .30-06 rimless cartridge. This required modifications to the machinery producing rifle barrels, receivers and magazines.

On January 2, 1918, the Remington Arms Company of Delaware was fully absorbed by the Midvale Steel and Ordnance Company, a subsidiary of Midvale Steel Company. MSOC operated the plant until after the close of the war. The company declined comment on the change of name. Various newspapers speculated it was in anticipation of possible contracts for the Browning automatic rifle.

The completion of rifle number 1,000,000 for the United States Government was celebrated by a mass meeting held on September 23, 1918. The meeting was attended by a number of notable army, navy and industrial officials, and by more than 14,000 employees of the plant.

During the three years rifles were made at the plant it was hindered by persistent labor problems of workforce turnover. Scarce skilled workers tended to migrate from one firm to another seeking higher wages. Midvale Steel, unable to

keep up with the high demand for gun quality steels and armor plate steel purchased Cambria Steel at Johnstown, Pennsylvania and Worth Steel Company at Coatesville, Pennsylvania. Samuel Vauclain, a director of Midvale* took a leading role, aiding in the purchase of these steel works.

Operations at the rifle plant ceased on January 2, 1919, at which time nearly 300,000 rifles were in process of manufacture. The Government then leased the premises for a storage plant. It was not reactivated for use as a locomotive boiler shop until 1926.

The total number of rifles manufactured in this plant was 1,949,954, in addition to spare parts equivalent to 200,000 rifles. The greatest production exceeded 7,000 rifles per day, and the maximum number of employees was 15,294. Nearly two-thirds of all the rifles used in combat by the American Army in France were manufactured at Eddystone.

Eddystone Ammunition Corporation of New York

Early in 1915, Messrs. J. P. Morgan and Company, representing The Czarist Russian Government, were requested to negotiate with American manufacturers for the production of three-inch Russian shrapnel. A tentative agreement for the manufacture of 2,500,000 shells was made. Such firms as Morgan and others held direct



The Eddystone Munitions Company plant looking west from the banks of the Delaware River, in Eddystone, Pennsylvania, during construction in 1916. Much of the live rounds of ammunition for shrapnel, and bullets were manufactured here for use in WW I. After the war the building was used for storage until circa 1924, when the left half was transformed into the frame machining shop and the right half into locomotive cylinder machining for The Baldwin Locomotive Works. The power house is in the center of this view. -- BLW Photo

financial interest in the outcome of the war in Europe and the Russian Revolution (whites versus the reds). They stood to gain or lose substantial monies based on the outcome of the two conflicts. It was in their interest to keep supplies and war munitions flowing and thus encouraged those with financial ties to their organizations to become directly involved in contracts. Because the Charter of The Baldwin Locomotive Works did not permit it to handle explosives, a new subsidiary firm was formed for the purpose of carrying out ammunition contracts.

Separate from the manufacturing of the British rifles was another entity in the growing arsenal at Eddystone, The Eddystone Ammunition Corporation. Its purpose was to enter into partnerships with other firms for the manufacture of light and heavy ordnance and munitions. It was formed as a direct subsidiary of The Baldwin Locomotive Works, on June 10, 1915, with Samuel M. Vauclain as Managing Director, Andrew Fletcher as President, Captain Walter M. Wilhelm as vice-president and general manager, and John P. Sykes as Consulting Manager. The stock of the Company was held and owned away from The Baldwin Locomotive Works because of exceptions in the Charter. This firm appears to have been a subcontractor for munition manufacturing, han-

dling overflow work from Midvale Steel and Ordnance. It was not a direct holding of Baldwin's but a tenant controlled by senior executives from Baldwin, and several affiliated suppliers.

The Russian Imperial Government (White Revolutionaries) signed a contract, calling for 2,500,000 rounds of three-inch artillery ammunition with shrapnel shells, was executed on July 23, 1915, for completion by December 31, 1916. Work was immediately started on the construction of the plant at Eddystone, which was located east of Essington Avenue on 65 acres along the Delaware River. It was swamp land at the time.

By February, 1916 the plant was mostly under roof and expected to begin manufacturing within 30 days. The Eddystone Munition Plant was looking for many female workers. Newspapers advertised work for a thousand girls. The work was to be piercing fuses to be fitted into shells. Ads seeking girls to work in the plant were placed in Philadelphia and other large newspapers in the area. By September 1916, the *Chester Times* reported more than 10,000 men and women employed by Eddystone Ammunition. All this increased activity proved to be both a boon and a nightmare for the people of Eddystone. In 1910, the population was less than 1,000 people. By 1916, the *Chester Times* reported



This view, circa 1918 is looking east from the newly completed Remington Arms Company rifle plant (boiler shop). In the foreground is the Pennsylvania Railroad main line. The buildings include the Box Shop, Smith and Hammer Shop, Foundry and materials testing labs.

approximately 50,000 men worked in factories at the Borough of Eddystone. Alba Johnson, president of The Baldwin Locomotive Works, predicted there would be even greater growth in Eddystone and the population of the village would grow to 200,000 in a very short time. Transportation, housing and just feeding the workers lunch was a problem. Investors and companies were buying property to erect homes, boarding houses and hotels. It was said that every home in Eddystone that could, took in a boarder. Realtors were advertising for anyone with any available property to contact them immediately and within hours it would be fully rented.

The paper's August 16, 1916, edition went on to state: "It is estimated there are employed in all of the industries in Eddystone at least fifty thousand men. The question is often asked, "Where do all the men eat at least one meal a day? Outside of eating at the plants, Dempsey Brothers Restaurant, 13th and Simpson Streets, feed from four hundred to five hundred in a single meal and would feed more but for the lack of room. Casey's Hotel, 13th Street, often has three hundred men at a single meal. the Baldwin Hotel on 11th Street has three hundred men at a single meal. The Girard Hotel on 9th Street is farther away from the big plants than the others, but it also has a big crowd of hungry humanity. It is thought the number of men who eat at least one meal in the Borough is about ten thousand a day."

Many enterprising residents established pie carts at the gates to the plant and sold pies to the workers, selling out as quickly as the pies could be served.

The main buildings of Eddystone Munitions consisted of two connected buildings each four hundred and fifty by seven hundred and fifty feet, connected to an office building fifty by four hundred and fifty feet, which, was placed between them. These buildings were of steel and tile construction, two stories high; the upper floors of the shop buildings being removable, so that cranes could be subsequently installed for post-war production. These two buildings, after 1919 became

the cylinder machining and frame machining for locomotive manufacturing.

A large number of smaller structures, which were used for powder loading buildings, storehouses, magazines, etc., were also erected. The office building was completed and occupied November 1, 1915, with the manufacturing plants completed shortly thereafter.

With the entry of the United States into the Great War, the United States Government requested the Eddystone Munitions to submit a proposition covering the manufacture of a large amount of three-inch shrapnel. Because of British and Russian contracts the proposed program could not immediately be accepted. In May 1917, the United States Government agreed to purchase the machinery and equipment of the Eddystone Ammunition Corporation.

For nearly a year previous to the organization of the Eddystone Munitions Company, James McNaughton had been directing the affairs of the Eddystone Ammunition Corporation as personal representative of Samuel Vaucrain. He was well qualified to assume the presidency of the new Company. On October 1, 1917, he was also appointed Consulting Vice-President of The Baldwin Locomotive Works.

Pier 251

A deepwater wharf and pier were built in 1915, along the Delaware River front during the start of arsenal activity at Eddystone. This wharf was originally equipped with one fifty-ton gantry crane. It had a minimum depth of thirty feet of water alongside, so that large ocean going ships could dock and load.

The Eddystone Plant was located on the west bank of the Delaware River about 14 miles below the City of Philadelphia. The Delaware had been dredged to provide a ship channel 800 feet in width and 35 feet in depth at low water. At Eddystone the channel lies about 2,000 feet offshore. In 1915, when the port facilities at Eddystone were planned, Crum Creek, about 150 feet



The facilities of The Baldwin Locomotive Works and its WW I subsidiary plants at Eddystone, Pennsylvania circa 1918. After the end of WW I only three new building were added for the manufacturing of railroad locomotives; a large machine shop, tender and tank shop and the corporate office building. Two of the piers on the right were never built. This view looks west from the Delaware River. -- BLW Photo

wide and from two to six feet deep, flowed through the land selected as the development site for the shrapnel plant, which was low and marshy, reportedly being under water at high tide. In general terms the project included the diversion of Crum Creek to a new channel farther to the east, the reclamation of the marshy area through which it formerly flowed. The United States Government, in early 1916, was asked to handle all the dredging and relocation of the creek channel, and to dredge it deep enough to handle deep draft barges.

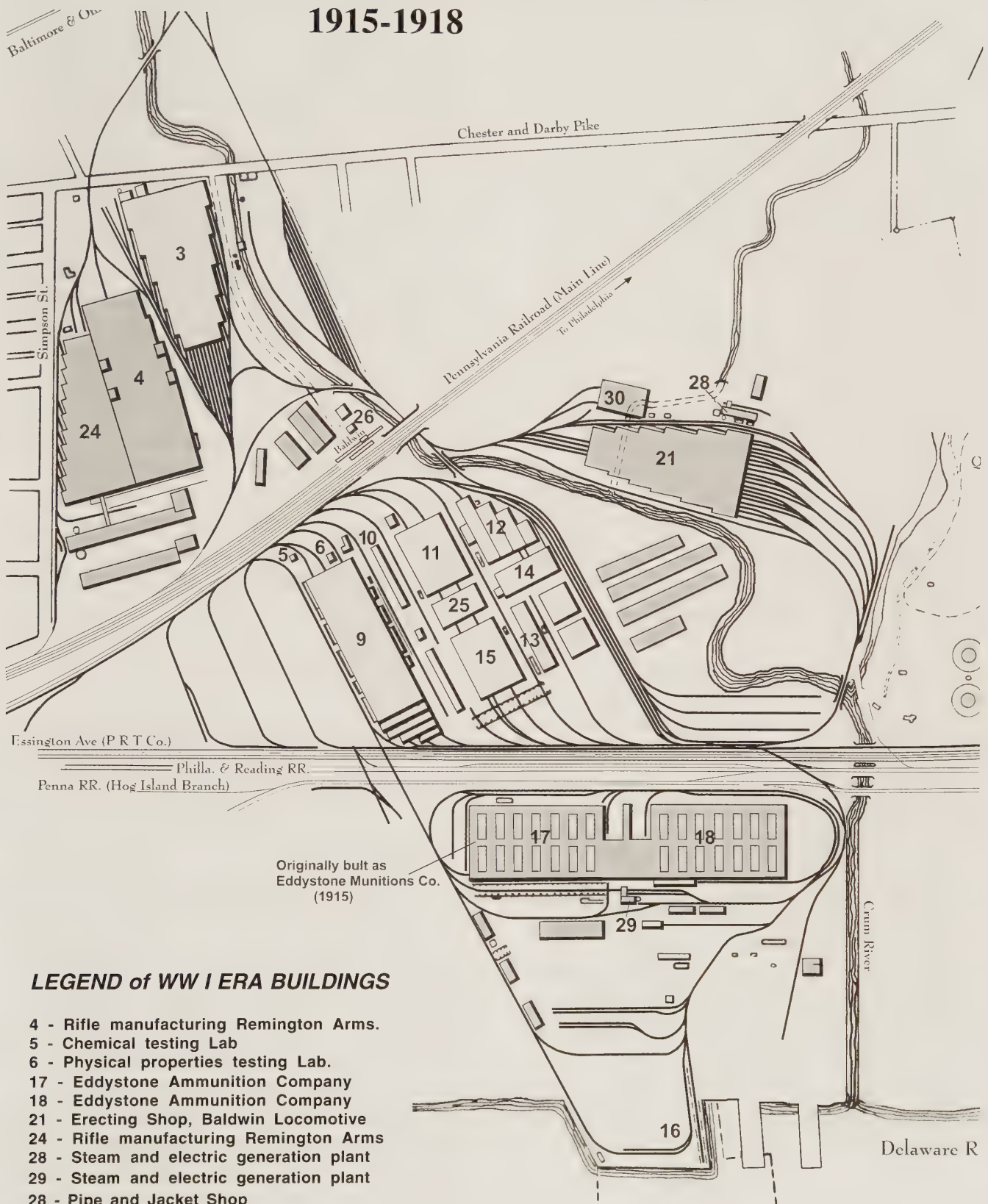
Construction upon the reclaimed land planned for of a system of wharves with suitable storage yards and railroad connections, and the provision of a turning basin and a dredged channel affording access from the wharves to the ship channel as well as ample space for maneuvering vessels at the docks.

The wharf on the Delaware River, built during the War, was a direct seaport access for Baldwin. The northeast front of this wharf was 560 feet

long, and was served by a gantry portal crane of 50 tons capacity. The southeast front, 640 feet in length, was used for package freight which could be loaded by ship's tackle. Both fronts were served by adequate railroad trackage. A turning basin 1,100 feet in diameter, and having a minimum depth of 30 feet of water, was located alongside the wharf. This basin connects with the main ship channel by a channel 300 feet wide, having a minimum depth of 22 feet at low tide, and a maximum depth of 28 feet at high tide. Seagoing steamers could be loaded at the plant, for direct shipment to any foreign port.

Because of a general increase in business of United States capital equipment builders at this time, difficulty was experienced in equipping the plants. Much of the heavy machinery was manufactured by The Baldwin Locomotive Works because it could not be obtained elsewhere in a reasonable time. The Baldwin Locomotive Works installed the large heat-treating plant for shell casings and gun parts and supervised its opera-

WW I Weapons and Locomotive Facilities Built at Eddystone, Pennsylvania 1915-1918



LEGEND of WW I ERA BUILDINGS

- 4 - Rifle manufacturing Remington Arms.
- 5 - Chemical testing Lab
- 6 - Physical properties testing Lab.
- 17 - Eddystone Ammunition Company
- 18 - Eddystone Ammunition Company
- 21 - Erecting Shop, Baldwin Locomotive
- 24 - Rifle manufacturing Remington Arms
- 28 - Steam and electric generation plant
- 29 - Steam and electric generation plant
- 28 - Pipe and Jacket Shop

tion.

The Eddystone Ammunition Corporation having procured the large shell contract also obtained a contract for proving Russian ammunition of their own and other makes. Just after the contracts were signed a proving ground of 4,000 acres was leased and on which were built test firing ranges north of Lakehurst, New Jersey.

By arrangement the Eddystone Ammunition Corporation was required to test ammunition for other manufacturers, and ammunition test lots representing some 7,600,000 three-inch Russian shrapnel and high explosive shells with their component parts were also tested.

Tests at the proving ground were of the greatest value, and were an unqualified success. On March 30, 1918, the United States Army took over the site and commenced construction of the Lakehurst Proving Ground for the purpose of testing gas warfare. A portion of that field was later established as the U. S. Naval Air Center of lighter-than-air (LTA) aeronautics, famed for the blimps and lighter than air ships.

Hazards of Ordnance Production

On April 10, 1917, four days after the United States declared war on Germany, at just before 10:00 A.M., a series of explosions occurred in Building "F" of Eddystone Ammunition Corporation. Building "F" a structure of 75 feet by 300 feet sat east of the main buildings near Essington Avenue. Time fuses were packed into shrapnel shells in this department. It was isolated from the main building on account of the large amount of black powder used. About 625 employees were in the building at the time. The explosions, three fierce shocks, and a series of minor ones shook the surrounding country side for about 15 miles.

Basil Greenko, a Russian inspector who survived the blasts was in the building at the time and gave his account: "*I was standing near one of the tables when suddenly from under the door of the loading room, there came a bright*

glare. Then instantly another bright light and I and everybody fell to the floor. I got to my feet but fell down again."

"There was no powder in the loading room, and no fire. Nothing but cases of empty shells, maybe 10 to 15 car loads. There was a heavy iron door between the loading room and the billet room and immediately with the first glare from under the door, the door was blown off and then the second burst of bright light, just as I turned to see what caused it."

"It was awful. Men and women falling all around me."

The *Chester Times*, in their Second Edition that day reported: "*When the first report of the explosion was heard the sight was sickening for amid flying bullets men and women dashed for every exit open. The first explosion was closely followed by two terrible reports that hurled the vast walls of the building to pieces and tore scores of men and women to pieces. Amid the wailing of the dying ones, bullets wrenched the air and sent terror into the hearts of the brave men and women who exerted every effort to escape.*"

The building was completely demolished. A large crater in the ground marked the point of detonation. First accounts from the scene indicated many workers were killed outright. Some were blown to bits, their remains found hurled across Crum Creek. Some may have been thrown into the nearby Delaware River. Officials feared those would not be recovered and forty-three remain unaccounted for.

Miss Helen Duffy, an employee also in the building at the time of the blast gave her accounting: "*When the first explosion took place it sounded like someone slamming a door and the room I was in became silent in a minute. We all stopped to listen. Then there came other explosions. Marie Smithers the forewoman, cried out; 'Run girls, run!' and we did run. Fear lent speed to our feet and we piled out of the building, across the yard of the Ridley Brick plant, to what we considered a*

place of safety.”

Immediately following the explosions a heavy guard was thrown up around the ruined plant. “A score of newspapermen, photographers who repeatedly tried to get through the lines were arrested.” All trolley service to and from Chester was ordered stopped to prevent the rush of curiosity seekers. Only cars for the use of the suffering and necessary supplies were permitted. The Pennsylvania Railroad sent a rescue train and supplies to the scene with doctors and guard from Philadelphia. All area fire companies responded to the scene and had the fires under control by noon. All available physicians and ambulance services were summoned. A morgue was set up at the Chester Armory. Families fearing the worst came to the hospitals and morgue searching for loved ones. The scene was horrific as names of the dead were posted.

Minor explosions continued throughout the morning, preventing the work of rescuers. Heroic work was done at the rescue, both by employees and also by outsiders who happened to be in the vicinity and who could reach the spot. One national account of the explosion stated: “*Some of the injured were temporarily cared for in build-*

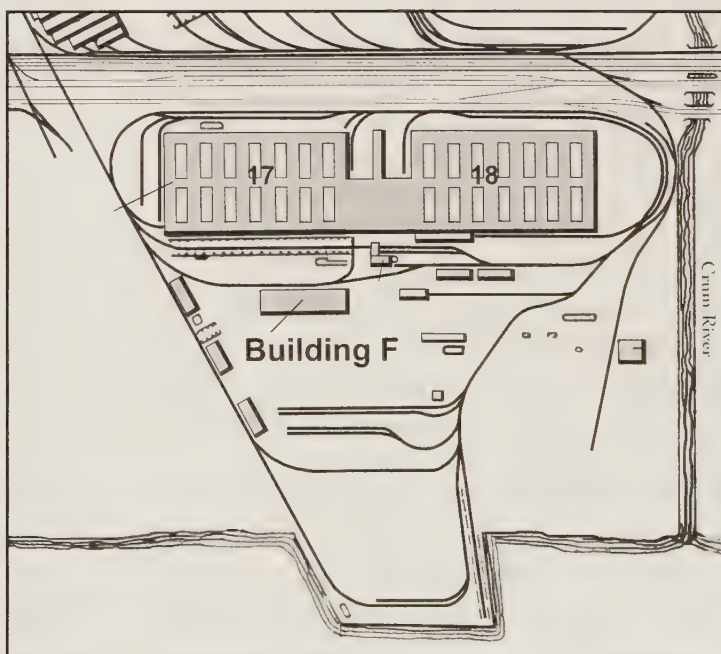
ings of the ammunition company, while scores of homes at Eddystone and nearby towns were thrown open to the others. At one residence in Ridley Park thirty-five persons were given attention. None of them had been hurt, but were in a state of collapse from shock and hysteria.

“There were numerous instances of heroism. In one of these Captain Walter Wilhelm, vice president of the Eddystone corporation and former national guardsman, dashed through smoke and flame into the wreckage no less than ten times, each time carrying someone to safety.”

Deputy Sheriff Frank Helf, early on the scene stated; “*The sight of that living suffering mass of humanity as they held out their arms for aid can never be described, but only imagined.*”

Samuel Ostopochuk, a Russian native had come to the United States seeking work, having left his young son and wife while seeking to make them a better life. He had made his plans to return to Russia and had told fellow employees he was going to buy his son some new clothes and his wife some gifts in preparation for quitting his job and leaving for the journey to his family. He

Building F was completely destroyed on the morning of April 10, 1917, in a mysterious explosion. Some 133 employees were killed in the explosion, 43 bodies were never recovered. After the war the plant was converted to machine shops and pattern storage, and largely shut down after 1929, not to be reactivated until 1940, then used for the production of military vehicles and weapons. It was shut down a final time following the end of WW II. The complex east of Industrial Highway was sold to PECO in 1953, who demolished the buildings and constructed a power generating plant on the site.



wanted to make just a bit more money before quitting his job. He was killed in the explosions.

Early estimates indicated 50 dead and at least 300 injured. In the next 24 hours, it was determined most of those killed and injured were girls and women and at least 80 were between the ages of 16 and 19. The hospitals at Chester and Ridley Park reported 75 of the injured were amputations, missing arms or legs and suffering serious burns. By the time the Third Edition of the *Chester Times* hit the streets that day, a list of employee names was being assembled as well as their injuries and survival status. Pledges of cash and goods were immediately forthcoming. The nearby Eddystone Print Works sent bolts of cloth to be used as bandages, the Red Cross and volunteers cut bandages. The newspaper set up a bulletin board and printed the latest news for the crowds to read at their front steps.

All of the dead were frightfully mangled. "Many were blown to atoms." The coroner was having a difficult time assembling bodies. Many noted he who had seen many terrible sights was greatly moved by the unfolding events and the dreadful condition of the bodies tendered to his authority.

One hundred and thirty-three people were killed by the blast, others lingered for days and weeks with critical injuries before succumbing. Fifty-two unidentified bodies were buried at a mass funeral in the Chester Rural Cemetery on April 13. At 9 AM all businesses closed out of respect and residents made their way to the cemetery. All 52 coffins were numbered and placed in a common grave. An estimated 12,000 people attended the funeral service. Twenty-two members of the clergy resided over the services including; Catholic, Methodist-Episcopal, Baptist, Presbyterian and Lutheran. Security and grave diggers reported 15,000 mourners filed past the open trench of the coffins before they filled the grave. That afternoon a number of double funerals were held for local girls who had worked at the plant.

The next morning a number of private funerals began in many of the surrounding communities

with a majority in Philadelphia, where many of the victims had resided.

The cause of the explosion was not immediately known. In a statement the next morning a spokesman said the tragedy, "*was a diabolical plot, conceived in the degenerate brain of a demon in human guise.*" Federal agents concentrated on many leads and twenty arrests were made within hours of the explosion. The cause of the explosion was never determined, however, there were a number of explosions in munitions plants and on vessels caring armaments to the allies between 1915 and 1917, many in New York, New Jersey and Pennsylvania. Some investigations indicated agents and saboteurs of the Kaiser's Imperial Germany were highly suspected. The plant was returned to production within two weeks.

A second explosion occurred during the height of shrapnel production for the United States Army on September 11, 1918. One employee was killed and 17 others were injured when a carelessly dropped fuse exploded in a conditioning building behind the main building off Essington Avenue. This particular structure had blast walls applied some months before and focused the blast upward, avoiding further damage to adjacent buildings. An investigation verified it was the accidental dropping of a fuse that triggered the explosion.

Eddystone Munitions Company

The Baldwin Locomotive Works, had received \$97 million in war orders in July 1915, when it determined to organized a direct subsidiary company to manufacture the munitions. It was on September 27, 1917, the Eddystone Munitions Company formally came into existence. This was a necessary action to take over the function of Eddystone Ammunition, which had been originally formed as an indirect business to manufacture the Russian shrapnel.

Officers of the Company were as follows:— Charles H. Schlacks, Chairman of the Board.

James McNaughton, President. Captain Walter M. Wilhelm, Vice-President. J. L. Tate, Secretary and Treasurer. W. C. Stagg, Assistant Secretary and Treasurer.

Additional manufacturing capacity was required in order to handle all the munitions work, and a third major shop, generally similar to the erecting shop constructed in 1912, was built during the winter of 1917-1918 at a cost of \$3,000,000. The building had been planned in early 1916 but with two buildings going up at the Broad Street facility and a shortage of materials, the start of actual construction was prevented until late 1917. Work continued at a rapid pace and the 15 acre building was under roof by late March 1918. It was pressed into service for shell manufacturing in May 1918, initially employing between 4,000 and 5,000 men and women.

On April 1, 1918, a contract was signed for 1,000,000 seventy-five millimeter high explosive shells. The cartridge case shop, in the meantime, was manufacturing cartridge cases of high quality at the rate of 60,000 per week. In addition there were loaded, assembled and packed more than 1,600,000 rounds of seventy-five millimeter shrapnel, the component parts of which were furnished by the Government.

During the early months of 1918 the Government also ordered large quantities of various kinds of fuses, boosters and adapters, necessitating a number of changes in the shop layout and the installation of much new machinery. This was accomplished in a short space of time.

In addition to the work for the United States Government, a contract was made with the British Government for 500,000 six-inch high explosive shells. The armistice ending the war was signed before this contract was finished, but 475,000 of the shells were completed, with maximum production reaching 4,200 per day.

The maximum number of employees of the Eddystone Munitions Company reached 6,583. The labor situation presented many problems, due to the heavy labor turnover and the difficulty on securing skilled workers. Baldwin claimed

excellent wages, backed by a bonus system and considerate, tactful management, who did much to hold employees who would otherwise have sought employment elsewhere. The daily labor reports in the local newspapers contradict that image with a large turnover in employment reported.

After the signing of the armistice on November 2, 1918, production rapidly slackened. On December 31, 1918, shell armament manufacturing ceased. The machinery and equipment were sold, and the buildings turned over to The Baldwin Locomotive Works, most to be re-equipped as locomotive shops in the early 1920's.

Wartime Sacrifice and the Defense Industry Housing Shortage

As 1918 opened, the country was nearly paralyzed. A cold snap found the United States ill-prepared for the demand for coal, the primary heating fuel and the National Fuel Board was created to allocate available supplies. Supplies were being devoted to defense plants, military barracks, military shipping and designated defense plants. Plants not designated as defense plants were ordered to shut down immediately. Homes were to go without heat one day a week.

Baldwin Locomotive was not considered a defense plant and was ordered to shut down by Pennsylvania Fuel Administrator William Potter, until it was determined that railroad locomotives were considered a military vehicle or a vehicle that could be used in support of defense plants.

By early 1918, with the tremendous pressure from the influx of hundreds of thousands of workers into the neighboring ship yards, Baldwin and its Midvale (Remington) plants were in a squeeze to keep stable employment. Those two plants, which had combined employment of approximately 15,000, were finding a monthly turnover of nearly 4,000. They had turned to the hiring of women in January of 1918, to try and stabilize the problem. For the first time women became an important factor in stabilizing employment in the

factories, but even with women filling labor jobs, the plants reported they were still short by 1,100 employees. Worse, the women also had trouble finding suitable housing and committees were formed; Women War Workers, to find any reasonable housing in the area.

By early 1918 Baldwin officials were indicating frightful housing conditions in Eddystone. Since 1915 they had put a squeeze on the infrastructure when Baldwin became the first major wartime employer in the area and started the housing shortage. In 1918 worker housing was an impossibility. With the squeeze of an additional 100,000 workers in the ship yards, it pressed the region beyond any reasonable accommodation.

Congressional testimony indicated that the Midvale (Remington Arms) plant was nearly 1,000,000 rifles behind in its production schedule and munitions was producing 12,000,000 cartridges daily, about 30% of demand because of housing shortages. Baldwin Locomotive was at peak production of about 10 locomotives daily, part coming from the Broad Street plant in Philadelphia where 20,000 men were employed, and the majority being produced in Eddystone, most for export to the war effort in Europe. ~

Baldwin, Midvale, Sun Ship, Chester Shipbuilding, Westinghouse and American International Shipbuilding began pressuring Congress for emergency relief for workers in the form of rapid construction of complete suburban communities for workers. From late 1917 they sought special schedules for trolley and commuter railroad service and had even resorted to converting any available warehouse space in the region into temporary quarters for workers.

Aid was brought to the area in October, 1918 with a Congressional appropriation of \$14,000,000 to furnish 1,200 homes for Remington Arms Company and Baldwin Locomotive Works employees. The housing tract was located west of the Baltimore & Ohio Railroad. As early as 1912 Baldwin had been buying land at nearby Ridley Park in anticipation of construction company-owned housing to rent to employees willing

to relocate from Philadelphia and work at Eddystone.

Other war time industries saw similar relief. Provision for the appropriation was made in a bill which Representative Clark of Florida, chairman of the Public Grounds and Buildings Committee of the House reported to Congress.

The bill carried appropriations totaling \$194,607,000 for housing in all parts of the country, nearly half of it going to industry in the Delaware River region between Philadelphia, Pennsylvania and Wilmington, Delaware.

In January 1918, local health officials began warning the residents and factories to make every effort in the prevention of an outbreak of disease and the possibility of an epidemic. They wanted school buildings closed and fumigated after a marked rise in the incidence of contagious disease. The diseases they were concerned about were scarlet fever, scarlatina and mumps. The usual wintertime diseases of colds and the flu, or grip as it as referred to at the time, were not mentioned.

In early September 1918, hospitals started seeing a sudden rise in flu. It was first seen around east coast ports and its victims were soldiers returning from France. It was recognized with rapid onset of fever, aches, respiratory problems and general weakness. It was the Spanish Influenza with a new twist, it had a complication of pneumonia and was killing many of its victims.

The workforce at the Eddystone defense plants was soon off by 10% because of the flu. By September 23, it had finally made the Chester newspapers with a reported 50 cases. Health directors were giving pointers to all the defense plants on how to minimize the spread of the disease before it came to epidemic proportions. Things got worse rapidly and by October 1, the Grip was bringing much of the United States to a halt. Local newspapers carried the epidemic as front page news and when the first wave of deaths was realized a general closing of all public places was imposed. In the Eddystone area it included all theatres, moving picture houses, play houses,

saloons, pool rooms, bars, ice cream, soda and soft drink fountains, churches, schools, Sunday schools, carnivals parades and any nonessential meetings not directly related to the war.

The epidemic of influenza, seriously affected the work of the Company on account of the great amount of illness among the employees. Among the first to succumb was 33 year-old Captain Walter M. Wilhelm, Vice-President, who died on October 3, from the flu-related pneumonia. He was in charge of production of the Russian shells and rifles. He had thought he was over it, all excepting for a bad chest cold when he expired at home. His remains was taken to his home town of Defiance, Ohio, for burial.

On October 4, over 5,000 cases were reported in the Eddystone-Chester area. Production continued to drop at all the plants as employees fell victim to the flu. When Philadelphia and Chester hospitals were full, temporary hospitals were opened, first in the Chester Armory and when it was full the Odd Fellows Hall was pressed into service. The defense plants opened temporary hospitals to care for sick workers. Trolley service was limited to no more riders than there were seats in the cars and all nonessential travel was discouraged.

The reality of the epidemic became known with the presence of empty coffins being stacked on the street corners. The health care providers ran out of healthy staff and pleas went out for any volunteer with two hands and a strong back. The embalmers were working to exhaustion themselves, there weren't enough grave diggers to handle the demand and prisoners were brought in to help dig graves.

Baldwin and Midvale were seriously affected. Over a period of three weeks thousands of people died in the Delaware River area. Philadelphia reported over 12,000 deaths in approximately three weeks and just under 16,000 deaths in the 27 weeks the pandemic of Spanish Influenza lasted. The number who died at Baldwin or the other defense plants is not recorded. Over 33,000 died in New York City and 14,000 in Chicago.

War Industry on the Delaware River

The start of hostilities in Europe in August 1914, marked the start of The Great War. The Germans opposed the French and Russians. Great Britain was obligated to intervene on the basis of treaties with the Belgians, whose land it was necessary for the Germans to cross in order to attack France.

The Russian white revolutionaries had been struggling to overthrow their Czarist Government since about 1905, thus pressuring Russia on two fronts of war.

The United States remained neutral to the war even though the *Lusitania*, was carrying American citizens on-board when attacked and sunk by the German Navy in 1915. Germany declared, at the end of 1916, that it would begin unrestricted submarine warfare in an effort to break British control of the seas. In protest the United States broke off relations with Germany in February 1917, and on April 6, 1917, entered the war. American participation meant that the Allies now had at their command almost unlimited industrial and manpower resources, which were to be decisive in winning the war. Emergency Fleet Corporation, an agency of the United States Government entered the picture with an immediate need to build three ship yards at the beginning of the United States Entry into WW I.

The United States remained neutral for those 32 months between August 1914, and April 1917.

The Philadelphia area was the second hardest hit area in the United States.

Railway Gun Mounts

One of the most notable achievements of The Baldwin Locomotive Works during WW I, was



It had however, become a major munitions, ordnance and defense materials supplier to the French, British and Russians. History has disclosed several private interests held a role in the outcome of two major conflicts such as the consortium of American International Corporation, industrialists and several leading financial houses of that day.

Significant war manufacturing sprung up along the Delaware River from Philadelphia south to Wilmington, Delaware. At least one director of The Baldwin Locomotive Works and two of the

leading financial houses involved with Baldwin were involved in this massive wartime industrial expansion. Baldwin's establishment of the Remington Arms Company in 1915 was the first of many significant arms manufacturers to build on the marshland south of Philadelphia along the Delaware River. The addition of Eddystone Munitions Company, another Baldwin subsidiary was next. Several shipbuilders were established within 50 miles of Philadelphia. The most controversial was American International Shipbuilding Corp., built on a marshland in the Delaware

the building of a group of railway gun mounts for the United States Navy. These mounts carried fourteen-inch naval guns, similar to those on naval destroyers, which were available for shore service. The original idea was to use them against a number of long-range German guns which were mounted near Ostend and firing into Dunkirk. The designs for the mounts were prepared at the

Naval Gun Factory, Washington, under the direction of Captain A. L. Willard, Superintendent; Commander Harvey Delano, U. S. N., and George A. Chadwick, Chief Draftsman. When the designs were submitted to the bidders on January 25, 1918, Samuel Vauclain, who was then Chairman of the Munitions Committee of the War Industries Board, agreed that The Baldwin Loco-

known as Hog Island. It was built in just 10 months amid much scandal and congressional investigation almost from the start. The yard came to employ 36,000 men and laid its first keel February 12, 1918. Its first ship was not finished in time for use in WW I. Popular luncheon sandwiches eaten by shipyard workers there became known as hoagies. A total of 122 ships were built. It operated from 1917 to 1921 and the property was eventually sold to the City of Philadelphia.

Philadelphia Naval Shipyard, at the junction of the Schuylkill and Delaware Rivers, Philadelphia, Pennsylvania was an extensive yard used for outfitting ships only until 1917, when it was expanded to include complete ship construction.

William Cramp & Sons Ship & Engine Building Company, of Philadelphia, was a leading builder of ships, first from 1830 to 1927. It became a subsidiary of The Baldwin Locomotive Works in 1927 and its ways were closed and speciality ship component production moved into the Baldwin Eddystone complex at Eddystone.

Sun Shipbuilding & Drydock Co., Chester, Pennsylvania was established on 53 acres with five ways to build ships for the WW I marine fleet in October 1916. It survived the post war recession as a merchant ship builder.

Chester Shipbuilding Corporation Ltd., started shipbuilding activity in 1916 with an orders for 11 mine sweepers. Ships were sliding down the ways by early 1917.

Merchant Shipbuilding Company, Bristol, (Chester), Pennsylvania, was started in 1917. Built by the Emergency Fleet Corporation for \$12 million. Created town of Harriman, named

for the principal owner of W. Averill Harriman, owner of the Union Pacific Railroad. They managed to deliver 40 of 60 ships originally ordered. First keel laid February 16, 1918, last ship delivered Feb 28, 1921.

Betts, Harlan & Hollingsworth Shipbuilding Co., Wilmington, Delaware, entered the manufacturing of ships in 1836. Built 70 ships during WW I. Acquired by Bethlehem Steel in 1902. Shipyard was closed after WW I at the end of 1918. Railcar production continued under American Car & Foundry.

Pusey & Jones Corp., Wilmington, Delaware operated a small shipyard on the Christina River where smaller vessels were built.

Across the river at Camden, New Jersey was the New York Shipbuilding Company, operating the largest shipyard prior to the opening of the AISC yard at Hog Island, and down river was the Hercules Powder Company.

Orders for the Delaware River Shipbuilders in July 1916 were announced as:

BUILDER	SHIPS GROSS TONS	
New York Shipbuilding	16	115,473
Cramps Shipyard	11	76,009
Harlan & Hollingsworth	14	62,555
Chester Shipbuilding	11	52,500
Pusey & Jones	6	9,600

Other entities in the immediate area included J. G. Brill, makers of street railway and interurban cars, who entered into the production of shell forgings.

Munitions Company of Chester, Pennsylvania, was started in 1916 to make larger shell casings.

In the highly concentrated war industries along

motive Works would build the mounts, with the assistance of the American Bridge Company. Five mounts were ordered; the first one was completed on April 25, 1918, the last was completed May 25.

Each mount was carried on twenty-four wheels, grouped in four trucks of six wheels each. The maximum firing elevation of the gun was

forty-three degrees; but when firing at angles of fifteen degrees and upward, a structural steel foundation, surrounding a pit, was necessary, for the purpose of absorbing a portion of the shock and providing room for the recoil of the gun. These foundations were also supplied by The Baldwin Locomotive Works.

By the time the mounts were completed, the

the Delaware River, Westinghouse Electric and Manufacturing Company announced plans on June 27, 1916 to construct a massive plant near Essington at the mouth of the Delaware River and Darby Creek for the production of electrical apparatus. This plant was projected to employ between 10,000 and 15,000 men. Ground was broken for this complex in late 1916.

The newly acquired Baldwin subsidiary, Midvale Steel and Ordnance, operating its original plant at Nicetown, Pennsylvania, purchased Diamond States Steel of Wilmington, Delaware and reopened it as Wilmington Steel Company. In addition Midvale purchased the massive works of the Cambria Steel Company at Johnstown, Pennsylvania; which also included the Buena Vista ore mines in the nation of Cuba and a 50% interest in the Mahoning Mines for Pennsylvania coal. Added to that was Worth Brothers Company, another steel mill in Coatesville, Pennsylvania and the Remington Arms Company of Delaware at Eddystone.

The Nicetown plant manufactured armor plate, gun barrel steel, shells and ordnance, plus common grade steel. During WW I it was converted almost entirely over to ordnance manufacturing. Cambria Steel manufactured merchant grade steels and during WW I manufactured ordnance.

The Coatesville plant took much of the work formerly produced at Nicetown and in addition made boiler plate, tubes, and merchant grade steels. In February, 1916, Coatesville underwent a major expansion, adding six smaller 50 ton blast furnaces, a 500 ton blast furnace,

a bloom mill, a massive machining and forging department, bar mill, wire department and rolled wheel department.

The plant at Wilmington, Delaware, manufactured merchant grade steels after its purchase out of bankruptcy.

This was unprecedented expansion in a very concentrated area of rural and small town fabric along the Delaware River, all within an 18 month period. It brought tremendous pressures upon the infrastructure. An already tight labor market was squeezed even harder. Workers from Baldwin and Remington went to work at one of the shipyards or for a contractor building new plants and facilities. Adding to that the borders of Europe had been closed and those immigrants who might have been available to fill job in the expanding wartime economy were not available. Consequently job hopping became a common practice along with a demand for higher wages.

The Federal Government undertook the dredging and deepening of the Delaware River to handle the deeper draught ships. Marshland along the banks was filled with the muck, water and sewer lines were laid and immense factories were built.

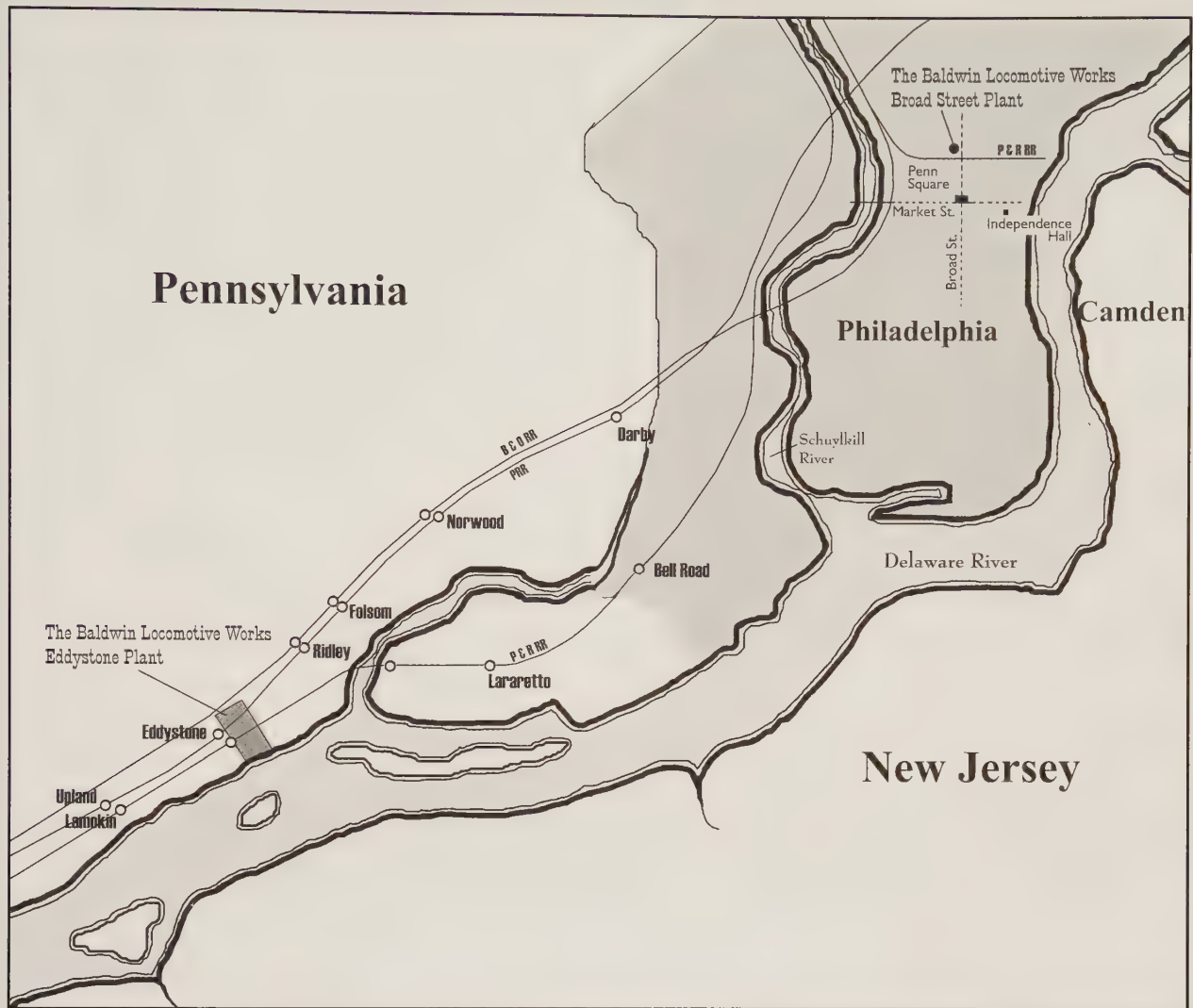
Housing needs, tight by the first arrival of Baldwin and Remington at Eddystone were blown away with demands for emergency housing in terms of thousands of housing units. Roads required paving, street railway and trolley lines, a highly desirable form of transportation in that day were quickly adding new lines and double tracking on certain major routes out of Philadelphia.

The railroads were adding additional lines, yards and car and locomotive shop facilities in the

battle front in Europe had changed to such an extent that it was impossible to send them to the Belgian Coast as first intended; hence they were shipped to the West Front, and were in service several weeks prior to the signing of the armistice. In all, the five batteries were fired 782 times on 25 different days, at ranges which averaged from 30,000 to 40,000 yards (17 to 22 miles;) and

while it was not possible, in the majority of cases, to make forward observations, it is known that severe damage was done.

These first five mounts were followed by six others, of similar construction; and after the signing of the armistice, the Works completed two additional mounts of an improved type with an 18 inch bore, and so designed that the gun could be



Philadelphia area They were especially hard hit in 1916 then, on November 10, 1916, the Pennsylvania Railroad embargoed all new freight movements on all lines within a 15 mile radius of Philadelphia. It was squeezed by demands for transportation going to the ports for export of war materials, then the German Navy undertook attacks on all shipping, diminishing limited capacity.

Then massive wartime industry construction started, pushing the railroad into a critical situation. The railroads responded by adding new tracks, ordering more locomotives, freight and passenger cars, but its employment was also unstable because of the pressures on the available work force and growing labor strife.

fired at all angles without transferring the weight to a separate foundation. The new mounts were given thorough tests and proved highly satisfactory.

The Works also built thirty-eight caterpillar mounts, designed to carry seven-inch rifles. These were also constructed for the Navy, having been designed at the Naval Gun Factory. This type of

mount has broad caterpillar treads, and can be run over rough roads and soft soil. In the field, these mounts are hauled about by tractors of one hundred and twenty horsepower.

In addition to building complete mounts, The Baldwin Locomotive Works constructed several styles of railway trucks for gun and howitzer mounts. At the time hostilities closed, prepara-



Baldwin purchased a fleet of Autocar trucks to move materials between plants in Philadelphia and Eddystone and suppliers as far away as Pittsburgh during WW I.

The influx of workers put a strain on churches, schools, hospitals, food suppliers law enforcement transportation and so on. Housing became so critical by mid-1918, that the war plants were petitioning the local governments for exemptions and support to quickly get housing up.

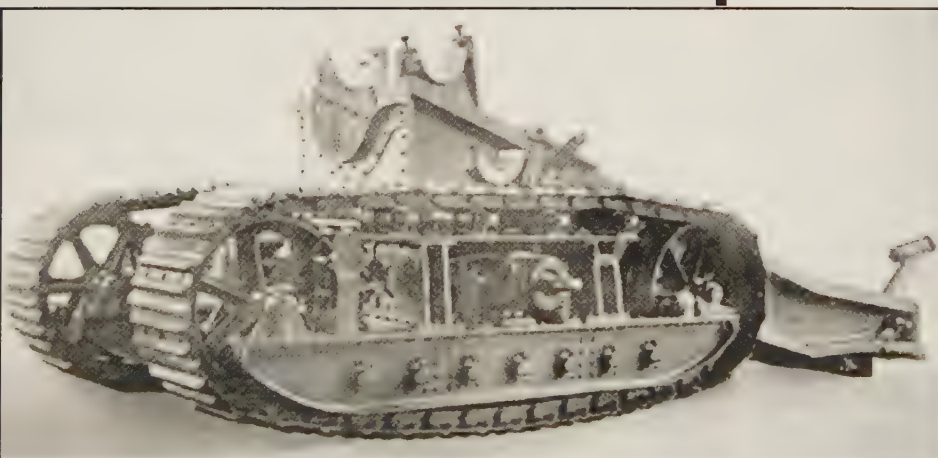
tions were being made for the manufacture, on a large scale, of heavy tanks equipped with Liberty motors. These were intended to destroy the wire defenses and machine gun nests put up by the Germans in their retreat. After the signing of the armistice, however, the order for the tanks was cancelled.

The war activities of The Baldwin Locomotive Works also included the construction of three large plants on their property at Eddystone for the manufacture of rifles and ammunition, and accomplishments in this connection constitute a series of achievements worthy of record.

Locomotives built.....	5551
Gun Mounts (7 and 14 inch).	51
Foundations for 14" mounts	20
Trucks for gun and howitzer mounts ...	5 sets
Total number of shells	6,565,355
Cartridge cases.....	1,863,900
Miscellaneous ammunition items. . .	1,905,213

The aggregate value of the war contracts executed and delivered by The Baldwin Locomotive Works, the Standard Steel Works Company, the Eddystone Ammunition Corporation, and the Eddystone Munitions Company, was approximately \$250,000.000.

Among those lost on board the Cunard steamer *Lusitania*, when that vessel was torpedoed by a German submarine on May 7, 1915, were W. Sterling Hodges and his family. Mr. Hodges, at the time, was en route for Paris, where



Caterpillar gun mount, designed to carry seven-inch guns. These were constructed by Baldwin for the Navy. This type of mount had broad caterpillar treads, and could be run over rough roads and soft soil. In the field, these mounts are hauled about by tractors.

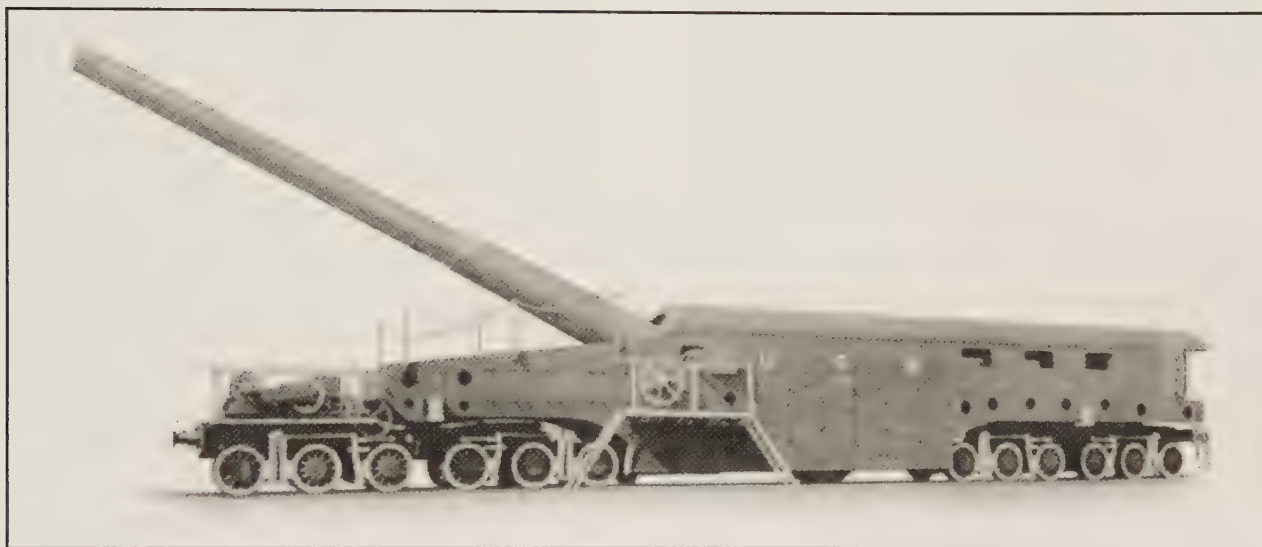
he was to act as one of the representatives of The Baldwin Locomotive Works.

With the entrance of the United States into the war, in April 1917, the presence of the American Army in France required the immediate construction of a great amount of motive power and rolling stock To meet the demand for locomotives, The Baldwin Locomotive Works were entrusted with what were probably the largest and most urgent orders ever placed in the history of locomotive building. The first of these orders for the famed

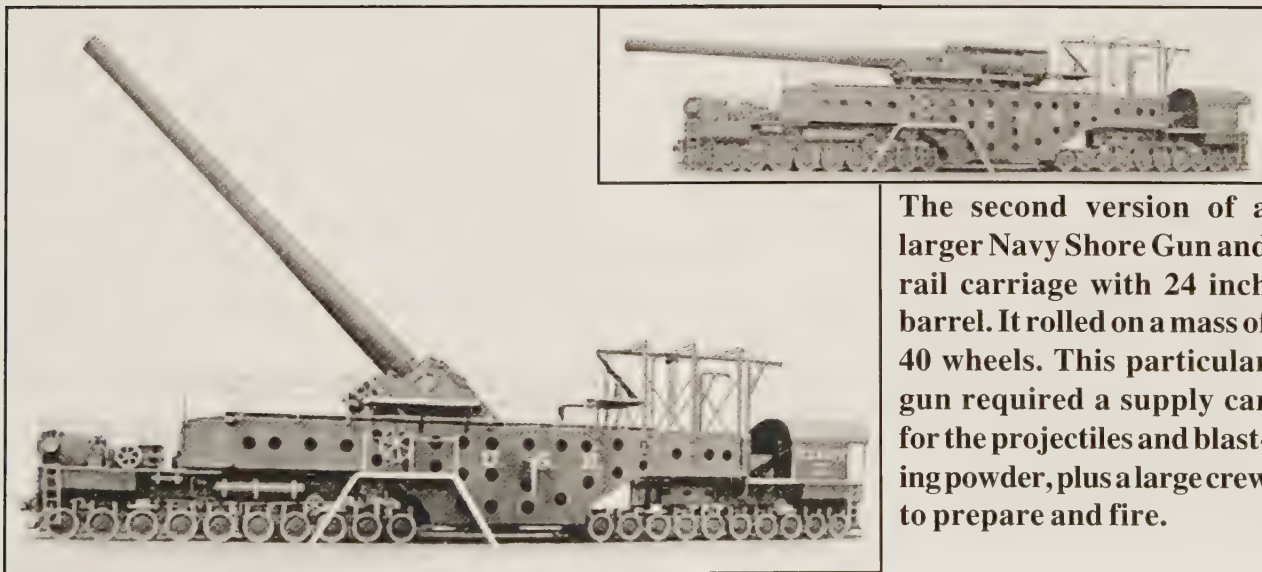
Pershing Engines was placed on July 17, 1917.

In addition to the Pershing locomotives, narrow gauge steam locomotives of the 2-6-2 type, and gasoline locomotives of the five, seven and one-half and twenty-five ton sizes, were also built for the United States Government's war needs.

On September 6, 1917, Samuel M. Vauclain was appointed Senior Vice-President of The Baldwin Locomotive Works, Grafton Greenough Vice-President in Charge of Sales, and John P. Sykes Vice-President in Charge of Manufactur-



Fourteen inch shore gun and rail carriage mount built for the United States Navy during WW I. This first version rode on 24 wheels. Five of these massive canons went to Europe and were shot a total of 782 times at a range of 30,000 to 40,000 yards. They hurled a projectile weighing 1,500 pounds. One has been preserved at the Washington Navy Yard.



The second version of a larger Navy Shore Gun and rail carriage with 24 inch barrel. It rolled on a mass of 40 wheels. This particular gun required a supply car for the projectiles and blasting powder, plus a large crew to prepare and fire.

ing.

Greenough entered the service of the Company on December 28, 1885, as an employee of the Engineering Department. In August 1899, he was transferred to the Operating Department in the capacity of Assistant Superintendent. At the time of the Louisiana Purchase Exposition in 1904 he was placed in charge of the St. Louis Sales Office, later assuming charge of the sales organization in Philadelphia as General Sales Manager.

Sykes was apprenticed to The Baldwin Locomotive Works, entering service in 1879. He served in the capacities of Contractor, Assistant Foreman and General Foreman until 1905 when he was appointed Superintendent of the new Eddystone Shops. In 1907 he left the parent company to become General Superintendent of the Standard Steel Works Company at Burnham, Pennsylvania, later returning to The Baldwin Locomotive Works as Assistant General Superintendent. In July 1911, he was appointed General Superintendent, the position he held until his selection as Vice-President in Charge of Manufacturing.

Battle Front Locomotives

World War I was the last war fought employing a great reliance on railroads for the immediate movement of both troops and supplies in great quantities to the battle front and in the trenches at the battle scene.

Samuel Vauclain, then Vice-President of The Baldwin Locomotive Works, visited Russia in the fall of 1914 and also early in 1915, and was instrumental in securing a large part of this business.

The first order thus obtained called for 30 Mallet locomotives of the 0-6-6-0 type, for the Vologda-Archangel Railway. These locomotives were of three feet six inches gauge. They were rapidly completed and shipped. This order was followed by others, placed later by the Russian Czarist Government, and covering large numbers

of heavy Decapod locomotives of five feet gauge, gasoline-mechanical locomotives of 75 centimeters (2' 5") gauge, gasoline trucks and gasoline tractors.

The gasoline-mechanical locomotives were intended for trench service, a class of work for which they were well fitted, since as they emitted no smoke they were comparatively inconspicuous. They also used no water other than for the radiator, a sometimes problem with the use of steam locomotives in the battle field.

The Russian railway engineers made one quirky specification in the design, the drive wheels were to have a flange on both the inside and outside of each tire. Even though they were told it would not work on a six wheel rigid frame locomotive, Baldwin built the test engine to specification and set it up on a test track at Eddystone. The locomotive bound tight on the sharp curves. The Russian engineers present for the tests made a quick decision to remove the flange from the outside of each wheel. The modified locomotive handily moved 18 tons without hesitation. The balance of the order was built with a standard wheel tread and one flange.

The French Government, late in the summer of 1914, sent a mission to the United States to make certain war related purchases. Early in November, 1914, the mission received cable instructions from France to purchase 20 tank locomotives of a gauge of 60 centimeters (1' 11"), which were to be built to American designs and shipped as promptly as possible. The Baldwin Locomotive Works took this order on November 3, and the 20 locomotives, ready for shipment overseas, left the Works on November 21. This was the beginning of a series of orders from the French Government which included both steam and gasoline-mechanical locomotives totaling over 1,000.

Among the French orders were 280 locomotives of the unique double boiler "Pechot" type, designed for service on the narrow (60 centimeter) gauge lines in the advanced areas of the war front. These locomotives were built to the metric

system of measurement, in accordance with designs furnished by the French Government. They were carried on two steam driven trucks or bogies, thus providing unusual flexibility and excellent tracking and riding qualities. The boiler had two fireboxes, placed in the middle between the bogies; and there was a separate boiler barrel, smokebox and stack at each end of the locomotive. The total weight in working order, with water-tanks and coal-boxes filled, was 28,100 pounds. These locomotives were built during the years 1915 and 1916.

The locomotives built for the British Government, for service similar to that performed by the Pechot locomotives, were of the ten-wheeled (4-6-0) type with side tanks. A total of 495 of these were built during the latter part of 1916 and the Spring of 1917. One hundred-fifty locomotives of the consolidation (2-8-0) type, were built in 1917. These locomotives had cylinders 21 inches in diameter by 28 inches stroke, and the weight in working order was 162,500 pounds.

The remainder of the standard gauge locomotives built for the British Government were of the 0-4-0T, 0-6-0T, 2-6-2T and 4-6-0 types. The last named had separate tenders, while the others were tank engines.

In addition to the locomotives built for strictly military purposes, large orders for Mikado (2-8-2) type freight locomotives were also received, during the war period, from two prominent French railways—the Paris, Lyons and Mediterranean, and the Nord. These locomotives were built to the metric system, in accordance with specifications furnished by the purchasing companies. They used superheated steam and were of the balanced compound type, with inside high-pressure cylinders driving the second pair of coupled wheels and outside low-pressure cylinders driving the third pair. The total weight of one of these locomotives, exclusive of tender, was 202,000 pounds, of which the driving wheels carried 149,400 pounds. The construction of all of these locomotives for military service abroad, together with those ordered by domestic railways, soon

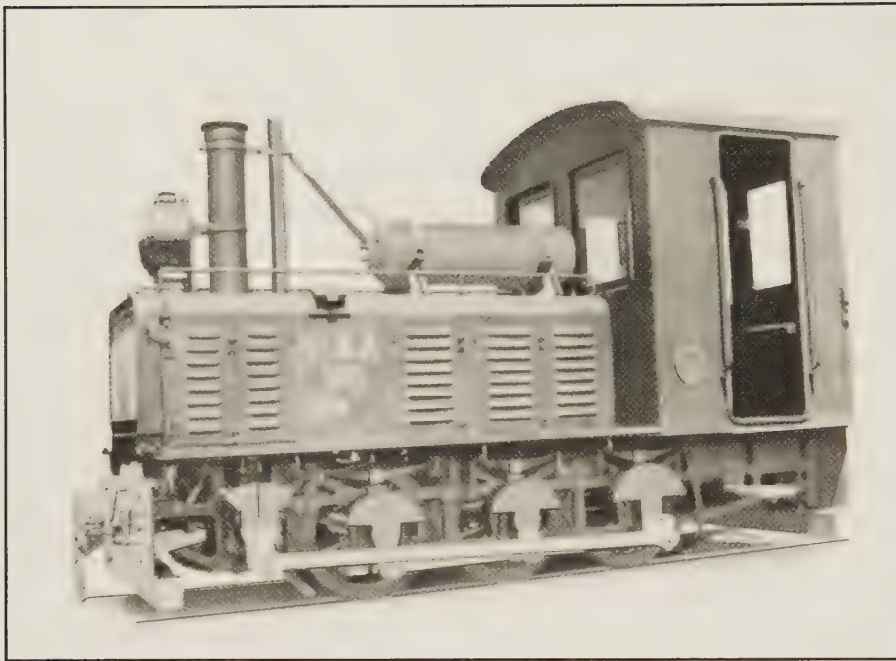
placed the both the Broad Street and Eddystone locomotive plants on a full capacity basis.

In early 1917 the British War Department began ordering a number of different wheel arrangement locomotives for use in France. The most popular wheel arrangement was the American design 2-8-0 built to standard gauge. It was quickly tagged with the name “Pershing Engine,” named after General John J. “Blackjack” Pershing. The Baldwin Locomotive Works were entrusted with what were probably the largest and most urgent orders ever placed in the history of locomotive building. The first of these orders for the United States Government and placement with the United States Army Transportation Corps was placed on July 17, 1917, and called for an initial order for 150 locomotives of the Consolidation (2-8-0) type. These locomotives, in general design, were similar to the Consolidation engines built for the British War Department, the principal difference being that they were equipped with superheaters, whereas the British locomotives used saturated steam.

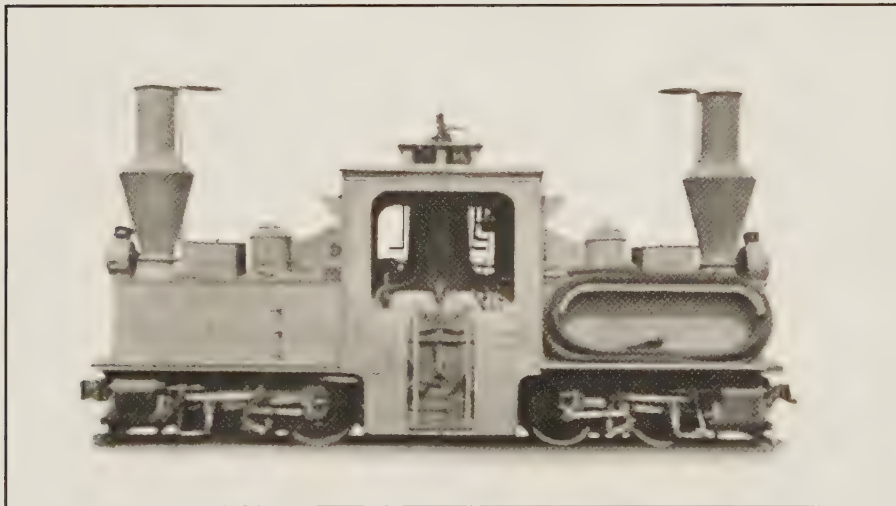
The first of the “Pershing” locomotives for the United States Government was completed on August 10, less than a month after the receipt of the order, and the last of the 150, on October 1. These engines were subsequently ordered in large numbers. When hostilities closed they were being shipped from the Works at the rate of 300 per month. When production of the Pershing Engines ceased in early 1920, Baldwin had produced 2,191 of the 2-8-0 design for use in the war effort. The United States Government purchased directly, 1,864 locomotives, the Polish purchased 144 and the Romanians took 25. The British War Department took 158 saturated steam (non-superheated),

Additional erecting capacity was required in order to handle all this work, and the second erecting shop, initially built to handle ordnance manufacturing was quickly converted to its final use for the assembly of locomotives. It was generally similar to that constructed in 1912.

Through the initiative of Sam M. Felton, Di-



Russian Gas-Mechanical locomotives, 350 were built between April and September 1916, 75cm gauge 50hp 26 C GM 7/1916 6-50-1D-5. The Russian Government sought these locomotives because of a lack of water and fuel required for steam locomotives in the trenches. They sought a wider gauge to discourage any sudden invasion by opposing armies.



Percot trench locomotive built for the French Government and French Army between March 1915, and December 1916. These unique locomotives were double boilers 60cm gauge, 6½x9½[4] with 25½" drivers and a wheel arrangement classification of 0-4-4-0T. Baldwin built 280 of these locomotives.



British and French trench locomotives built between September 1916, and January 1918. These unique locomotives were built for 60cm and standard gauge, 9x12 with 23½" drivers and a wheel arrangement classification of 4-6-0T. Baldwin built 495 of these locomotives.

rector of Military Railways, and his mechanical aide, Colonel Milliken, an interesting method was developed of shipping the Pershing locomotives to France, complete with the exception of the headlight, smokestack and cab. The locomotives and tenders were placed in the holds of the vessels on their own wheels, and after unloading them at St. Nazaire, France, comparatively little work was required before they were ready for service. Much time and trouble were saved in this way. The United States Army Transportation Corps literally pressed them into service at the docks.

The Russian Czarist Government was in the midst of a revolution of its own. An acute shortage of locomotives found the new "democratic" Russian Government (white revolutionaries) placing orders with Baldwin during early 1917 for a total of 330 60 inch gauge 2-10-0 locomotives, known as the "Russian" decapod locomotives. These locomotives used 25" x 28" cylinders and 52" drivers. The other was for 81 0-6-6-0 compoundallet articulated locomotives for the Vologda-Archangel Railway, built to 3'6" gauge. This locomotive featured an all-weather cab and a short tender with a standard four wheel truck plus a single axle-set affixed to the tender frame. The locomotives were 13" & 18" x 22" cylinders and 44" drivers. By the time the first were ready to be shipped in October, 1917, stability of the Russian Government was precarious and the locomotives were withheld from shipment.

The first locomotives rolled out the shop doors in May, 1917. Two-hundred of the decapods were shipped, but when the Bolshevik Revolution broke out (red revolutionaries) the United States Government halted all shipments to Russia in December, 1917. Baldwin was left with 100 decapods and 51 of the 0-6-6-0's. The decapods were acquired by the recently formed United States Railroad Administration for use on locomotive starved United States Railroads. The mallets were retained by Baldwin and eventually sold to the Anglo-Chilean Nitrate and Railway Company in Chile and the Mesopotamia Rail-

way.

In order to facilitate use of the decapods on the narrower United States Standard Gauge tracks, Baldwin shop forces were required to take down the running gear on each locomotive, heat the driver tires and slide them inward one and three-fourths of an inch on each side. The running gear was reassembled, the link-and-pin coupler was replaced with the heavier ARA knuckle coupler, buffers and end sill lights were removed. Compatible brakes were added to each locomotive. The locomotives were then assigned and shipped to railroads as traffic demands warranted.

The United States Railroad Administration

On April 11, 1917, railroads around the United States had pledged their fullest support with the United States entry into the Great War. They also wished to avoid government controls, cries being heard in many circles at the time.

The United States Railroad Administration (USRA) was established as an independent agency by Presidential Proclamation 1419, December 26, 1917, under authority of the Army Appropriation Act (39 Stat. 645), August 29, 1916. The USRA operated such railroads, coast-wise steamship lines, inland waterways, and telephone and telegraph companies as were seized by the government in the interest of national defense during World War I. Railroads were returned to their owners March 1, 1920, under terms of the Transportation Act (41 Stat. 470), February 28, 1920.

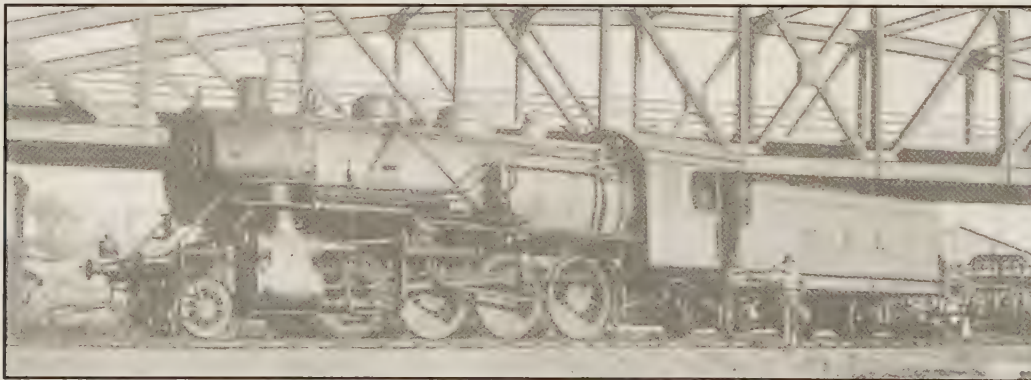
The USRA organization consisted of the Director General of Railroads and eight major divisions and seven regional offices. The first Director General, William G. McAdoo, was appointed on December 28, 1917. McAdoo had his work cut out. Railroads were taxed to the capacity of their limits, run down, broken down and financially strung out by the restraints of the Hepburn Act of 1906. Labor was restless and the industry was volatile to collapse.

To answer a critical demand for new locomotive and rolling stock, the USRA Division of Finance and Purchasing, was organized February 9, 1918. It was coordinated, through regional committees, for the purchase of railroad supplies and equipment. Samuel M. Vauclain, who was already seated on the War Industries Board was requested to chair a Committee for the design and standardization of locomotives and rolling stock for use on the railroads. Prior to this, most of the nations railroads custom ordered all of their locomotives and rolling stock, and the economies of standardized parts and mass production were not realized.

The USRA produced standard designs for 12 types of steam locomotives from the 0-6-0 and 0-8-0 switching locomotives, 2-6-6-2 and 2-8-8-2 compound articulated freight locomotives, and light and heavy versions of the 4-6-2 Pacific, 4-8-2 Mountain, 2-8-2 Mikado and 2-10-2 Santa Fe-type locomotives. The light versions were built with axle loads of about 54,000 pounds for service on light rail, and were designated with the suffix "A." The heavy versions used a 60,000 pound axle load, and were designated with the suffix "B." Some 1,856 locomotives of all types were produced during the reign of the USRA.

The USRA Locomotive Committee was established and charged with the responsibility for the design of the USRA locomotives. The committee used proven engine designs as a starting point, then incorporated the best of current technology, which resulted in modern but conservative locomotive designs. Because of this philosophy, the USRA engines were well balanced, durable and practical locomotives. The committee consisted of representatives from eleven railroads and the three major locomotive builders. Representing the locomotive builders were Joseph B. Ennis, Vice President Engineering of the American Locomotive Company, William E. Woodard, newly appointed Vice President Engineering of the Lima Locomotive Works and Harry Glaenger, an engineer at the Baldwin Locomotive Works. Because Baldwin, located in Philadelphia, was closest to USRA headquarters in Washington, the committee used the Baldwin's Broad Street office and drafting room to layout the blueprints for each locomotive design.

The Government assumed control of all the trunk line railways of the United States, December 28, 1917, at a time when the various lines were taxed to their capacity. The operation of the railways was intrusted to the United States Railroad Administration, which body immediately



The Baldwin Locomotive Works built over 2,000 of the "Pershing Engines," during WW I. This 2-8-0 wheel arrangement had been a mainstay of American railroads at the time. These engines were superheated. When the war ended there were still several in the final stages of assembly. Those were turn over to the Army for use at its many military camps around the United States. At least three examples have survived, two in America and one in Romania.

-- Author's collection

assumed the right to centralize the purchases of all railroad equipment, including locomotives.

The locomotive builders held the first conference at the office of The Baldwin Locomotive Works, March 13, 14 and 15, 1918, and subsequent meetings were held in the Interstate Commerce Building, Washington, with the result that an order for standard locomotives was placed and divided among the three builders April 30, 1918, and subsequent orders were placed with the last two companies named. Some locomotives of each of the twelve standard specifications were built by both The Baldwin Locomotive Works and the American Locomotive Company, whereas the activities of the Lima Locomotive Works were confined to two types of engines, the 2-8-2 and 0-8-0 types.

Baldwin was given an initial order for 1,025 locomotives, fully one-third of Baldwin's output for 1918. Vauclain desired the first completed USRA locomotive to come from his plant, and

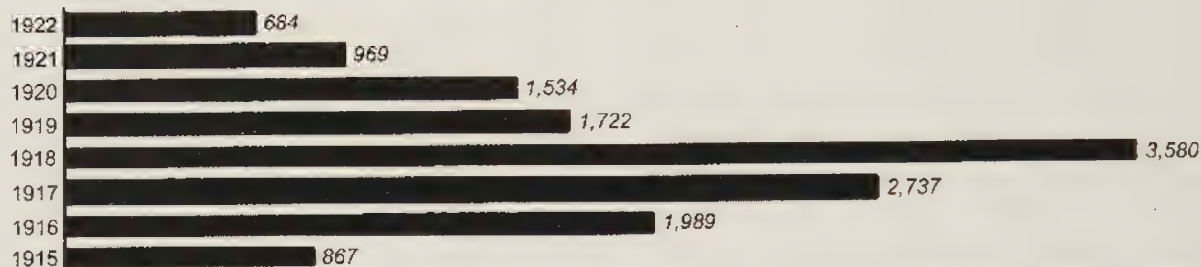
thus were laid the production schedule for a 2-8-2A, Number 4500 for the Baltimore & Ohio Railroad. From the time production started it took just 20 days to manufacture and assemble the locomotive. It was rolled out the doors of Eddystone on July 4, 1918, to a celebration of plant, railroad and government officials and employees. The locomotive was decorated in flags and bunting.

The standard locomotives were distributed to the various railroads of the country as directed by the USRA. The standard designs marked a significant turning point with a national standardization of designs. This in turn gave some measure of establishing fixed tooling for Baldwin and the other locomotive manufacturers. Reports of that era indicated lower costs of locomotives was made possible through standardization. If those advantages could be understood in the mind of the railroad world, the advantages which should have been obtained through the use of locomotives



Russian State Railways, 2-10-0 Number Ea 884, Baldwin Construction Number 47220 was 60 inch gauge with 52 inch drivers, built in December 1917. The first locomotives rolled out the shop doors in May, 1917. Two-hundred of the "Russian" or decapods were shipped. When the Bolshevik Revolution broke out the United States Government halted all shipments to Russia in December, 1917. Baldwin was left with 100 locomotives on the docks. The remaining "Russians" were acquired by the recently formed United States Railroad Administration for use on locomotive starved United States railroads. In order to facilitate use of the locomotives on the narrower United States Standard Gauge tracks, Baldwin shop forces were required to take down the running gear on each locomotive, heat the driver tires and slide them inward one and three-fourths of an inch on each side. The running gear was reassembled, the hook and link coupler was replaced with the heavier ARA knuckle coupler, buffers and end sill lights were removed. Compatible brakes were added to each locomotive. They were assigned to railroads as traffic demands warranted.

Baldwin Locomotive Orders 1915 - 1922



Baldwin Locomotive order books took some wild swings between the time of the outbreak of WW I and the end of mop-up and restoration of all railroads formerly controlled by the United States Railroad Administration. Locomotive orders never again met the 1917-1918 record years. Eddystone had been built in anticipation of orders for 3,000 locomotives a year. By the time of the Great Depression, one of the two Erecting Shops had been converted to other manufacturing.

tives particularly designed and adapted to the individual service of the railroads on which they operated should have moved the builders and the railroads into an era of cost efficiency and higher operating benefits. It was short-lived, and when WW I was over many of the railroads when back to individually designed locomotives with unique characteristics.

Only one order for nonstandard (not USRA) design locomotives was placed with Baldwin. The capacity of the plant was completely absorbed by the Government's demand for Military

Railway locomotives and for military and naval equipment. At least one order for 30 0-8-0 locomotives had to be diverted to Lima Locomotive Works for construction.

Baldwin Locomotive Number 50,000 was completed in September 1918. This engine was of the articulated Mallet type, with 2-8-8-2 wheel arrangement, and was one of a group of twelve, specially designed for service on the Appalachia Division of the Southern Railway System. These locomotives had been ordered before the USRA standardization program was decided upon.

The two Philadelphia plants reached reached a maximum employment of 21,500 men and women in 1918. Seventy-six acres at Eddystone were under roof and devoted to locomotive construction. Employment turnover was between 1,000 and 1,500 personnel every 30 days during the war years of 1917 to 1920.

USRA LOCOMOTIVE TYPES

Type	Style	No. Bld
0-6-0	6-Wheel Switcher	255
0-8-0	8-Wheel Switcher	175
2-8-2A	Light Mikado	625
2-8-2B	Heavy Mikado	233
2-10-2A	Light Santa Fe	94
2-10-2B	Heavy Santa Fe	175
4-6-2A	Light Pacific	81
4-6-2B	Heavy Pacific	20
4-8-2A	Light Mountain	47
4-8-2B	Heavy Mountain	15
2-6-6-2	Mallet	30
2-8-8-2	Mallet	106
TOTAL		1,856



Locomotive cylinder boring department circa WW I at Eddystone. During WW I Eddystone was turning out an average of ten finished locomotives every 24 hours, an amazing accomplishment. -- BLW photo



Baldwin Locomotive Number 50,000 was completed in September 1918. This engine was of the articulated Mallet type, with 2-8-8-2 wheel arrangement, and was one of a group of twelve, specially designed for service on the Appalachia Division of the Southern Railway System. These locomotives had been ordered before the USRA standardization program was decided upon. -- Author's collection



A United States Railroad Administration 2-8-2B built by The Baldwin Locomotive Works during U.S. control of the railroads. Many of these locomotives sat in storage for several weeks after assembly while the government tried to figure out what railroads should have new locomotives. Baldwin and Alco built over 80% of the USRA locomotives with newcomer Lima Locomotive building about 20% of the locomotives. -- BLW photo

The 1920s - Giant in A Shrinking Locomotive Industry

Post WW I Locomotive Manufacturing at Eddystone

While the greater part of the production of the Works during the war was for military purposes, a number of interesting locomotives were produced for domestic railway service. At the Panama-Pacific International Exposition, held in San Francisco during 1915, an exhibit of five Baldwin steam locomotives was presented: A 2-8-2 Mikado type locomotive for the Southern Pacific; A similar locomotive for the San Pedro, Los Angeles and Salt Lake Railroad; A 4-6-2 Pacific type locomotive for the Atchison, Topeka & Santa Fe Ry.; A 2-10-2 Santa Fe type locomotive for the Chicago, Burlington & Quincy R. R., and a stock locomotive of the 2-8-2 Mikado type designed for logging service. Two electric trucks were also exhibited; and an exhibit, made by the McCloud River R. R., included a Baldwin locomotive built for that line. The Works received the Grand Prize for locomotives and electric trucks.

In July, 1916, the first locomotives of the Mountain (4-8-2) type to be built by The Baldwin Locomotive Works, were completed. They were of standard gauge, for the Jamaica Government Rys. This type of locomotive was subsequently built in considerable numbers, for heavy passenger service in the United States and was one of the standard types designed by the USRA Mechanical Committee in 1918.

When the armistice was signed, it became necessary to turn attention to the problems of peace. It was found that the removal of war business, however gradually accomplished, would reveal a lack of balance in the general

organization of the Works and the saturation of the European market with "Pershing" locomotives. As a consequence of this business being obtained direct from the United States and Allied Governments, the Sales and Financial Departments of Baldwin remained undeveloped, while the Industrial Department had been enormously increased to take care of the emergencies of war. This lack of balance was particularly noticeable in the Sales Department, as war work had been obtained with practically no solicitation.

Baldwin had no long-term business plan to help it focus on a post WW I market. In adjusting to meet the new conditions, it was obviously necessary to expand the Sales Department so as to be able to obtain the business necessary to try and fill the greatly enlarged shops and manufacturing facilities at Eddystone. The opportunity for sales was especially attractive in foreign countries where Germany, formerly the most active competitor, had lost ground.

To inaugurate a necessary department to more vigorously pursue sales, the Sales Department, in March, 1919, was reorganized, and two distinct departments were created; one for domestic sales and a second to handle all foreign sales. Baldwin's long established Extra Work Department, with its record of past successes, was abolished. Grafton Greenough, formerly Vice-President in Charge of Sales, was made Vice-President in Charge of Domestic Sales. Francois de St. Phalle, who had been connected with Baldwin since 1903, and who during the war had acted as Manager of Munitions, was appointed Vice-President in Charge of Foreign Sales. Sales territories were organized on the basis zones. Twelve

direct Baldwin offices were opened in foreign countries, and men of the highest capacity selected and equipped to act as Baldwin managers.

Two orders of special interest, which were filled for export during the winter of 1919-1920. They called respectively for 150 locomotives for the Polish Government and 30 for the South African Railways. The Polish locomotives were of standard gauge, and were practically duplicates of the "Pershing" consolidation engines. The South African locomotives were of three feet six inches gauge, and of the Mountain (4-8-2) type. They had a total weight, exclusive of tender, of 250,000 pounds, and were claimed to be of exceptional capacity in view of the narrow gauge and the restricted clearance limits imposed. They were built in accordance with drawings and specifications furnished by the railway.

The first year of peace following WW I found Baldwin with orders for 1,722 locomotives, 102 of which were articulated. This was

the last year for large orders of the articulated locomotives. The United States Railroad Administration continued to operate the railroads, which made it tough to garner any significant orders from the individual railroads, just a wish list for future needs.

Railroads and other seized carriers were returned to private control from the USRA on March 1, 1920, under terms of the Transportation Act of February 28, 1920. The railroads were broken down, some were in a disastrous financial situation and traffic had suddenly dropped from wartime peaks. A very serious situation.

The first year the railroads could again order locomotives, 1920, found Baldwin fielding 1,534 orders.

Baldwin added another major building in the complex, the Machine Shop, during 1921. This at a time when all the major shipyards in the immediate area, including the massive Hog Island Shipyard of American International Corporation were silent and the tens of



Baldwin Eddystone plant switcher Number 21 c/n 48525 0-6-0 built May 1918, at the Broad Street plant in downtown Philadelphia. Note the slide valve steam chest on this locomotive. This photo was taken in the mid-1930s during a visit by a railroad buff organization to Eddystone, their train is in the background. Baldwin had several switchers to move cars throughout the massive facilities. The photo is near the tender shop. -- Author's collection

thousands who labored there were suddenly unemployed. This massive facility, built next to the erecting shop constructed in 1918, put 17 acres under roof. It included a brass foundry, complete machining and finishing of drive rods, valves, pistons, motion work and a complete store room area.

The facility, built on the east side of Crum Creek, sat across from the driving box shop. The building held much highly specialized machinery, used to progressively manufacture of locomotive parts. Baldwin planned the layout to handle parts for as many as 30 different classes of locomotives at a given time. Every component had to be made exact, finished and ready for application.

Baldwin described the machine shop, as a collection of shops divided into a brass foundry, several machine shops, storerooms to hold both raw materials and finished items. The brass foundry was originally located at the southwest corner of the building. Circa 1931, it was moved into the foundry buildings with the addition of the marine propeller line from Cramp. The general layout included the brass foundry, general storerooms, brass-finishing shop, machining for bolts and studs, guides and crossheads, main and side rods, motion work, steam pipes and cab fittings. The store-room also held many of the smaller items Baldwin did not purchase such as air brake appliances and equipment, stoker components, headlights, generators, whistles, pop-valves and associated items.

The brass foundry used electric furnaces and molding was carried out on a sand bed over concrete floors. An extensive network of crane trolleys covered the entire shop to move items of about any weight to any machine or store room.

The machine shop was filled with hundreds of special machines unique to the task of making locomotive components. Baldwin gave a glimpse of the comings and goings in the shop in their 1928 publication *The Story of*

Eddystone: "One such machine taps nuts, sixty to the minute, and the only requirement it makes is that the feed bin be kept full of the rough blanks. Two machines cut the taper threads on enough studs to supply the shops when running at full capacity—and each stud must pass a micrometer inspection. In the next bay, the lowly hack saw has been transformed into an electrically operated instrument of precision which cuts off guide ends, motion work blocks and valve rods at twice the speed of any other machine. Over in the side and main-rod bay there is a gigantic surgeon's trepan which cuts out discs of alloy steel fifteen inches in diameter and four inches thick. A two-minute operation will vary the size of the discs."

In addition to the massive Section D Machine Shop, Eddystone also saw the completion of a scale house, a building of some importance. It was able to weight a locomotive of 900 tons and weight distribution for any locomotive.

The buildings on the east side of Essington Avenue, originally belonging to the Eddystone Ammunition Corporation were reopened and changed over to locomotive manufacturing with the installation of a new cylinder shop machining shop. Building Number 17 was suited for the purpose. The arrangement of shop machinery allowed room for a system of railway tracks inside the buildings. All machines were powered by electric motors and overhead cranes served all parts of the shop.

The erecting shop facilities were greatly improved by the installation of a device to simplify the assembling of locomotive frames, designed by John P. Sykes. This device consisted of an adjustable form, or "jig," which would be set for the correct alinement of frame members for any size or type of locomotive, and for any gauge of track (US Patent 1,530,438.) Previously the correct lineup of frames called for a large measure of personal skill. The jig made the operation mechanically exact without special knowledge on the part of the assembly gang.

This expansion looked good to the investor market who saw Baldwin growing in the middle of

a region depressed when the defense manufacturing of WW I ended.

When 1921 had ended Baldwin's books were looking lean with just 969 orders on the books, and of those only 715 were for new steam locomotives. More stunning was the fact that only 339 locomotives were ordered by the domestic railroads, all others were export locomotives. This was not a good situation for Baldwin, who had to maintain three manufacturing sites.

In the third quarter of 1921 the Southern Pacific Railroad ordered 50 2-10-2's (SP Numbers 3968 - 3979 and 3680 - 3717). Each locomotive weighing 441,900 pounds. With the sudden decline in post war rail traffic there was no rush to ship the completed locomotives. They were held at the Works until the entire 50 had been completed in May 1922.

Sam Vauclain saw in this an opportunity to demonstrate there were bright spots in a lack-luster economy. He shipped three groups of these locomotives across the Continent each as single train. Two trains, consisting of 20 of the new engines each and one of ten new engines. Each engine had along its running board a large sign that advertised "Prosperity Special."

The train was called the "Prosperity Special" in the hope the name would symbolize happy days ahead. The journey was given widespread publicity by the press and was viewed by many thousands of people along the tracks. With considerable ceremony and after speeches the train left Baldwin's Eddystone Plant at high noon on Friday, May 26, 1922. It was moved over the Pennsylvania Railroad to East St. Louis, Illinois, and thence over the St. Louis-Southwestern (Cotton Belt) to Corsicana, Texas, where it was delivered to the Southern Pacific.

En route, mayors, governors and community leaders greeted the special with a succession of banquets, speeches and flashy public viewings. Schools were let out early to allow for witnessing

of the passing special. Overnight stops were planned at Division points and large cities. The Pennsylvania Railroad hoisted the special around Horse Shoe Curve with a brace of six locomotives.

Moving the Prosperity Special was not without incident. PRR plans to move the train via its Pan Handle Division were nixed because of tight clearances at Columbus, Ohio. It was moved instead onto the Fort Wayne Division from Pittsburgh, Pennsylvania to Fort Wayne, Indiana, only to have two of the locomotives walk off the rails at Fort Wayne while being moved for display. The train passed through Lima, Ohio, within two miles of Lima Locomotive Works, who, in a few years would pose a significant threat to the traditional thinking of Baldwin managers with the Super-Power locomotive design.

The Prosperity Special was moved south from Fort Wayne, 92 miles over the Grand Rapids & Indiana Division, all locomotives being towed backwards. At Richmond the locomotives arrived correctly positioned to pass through Newman Interlocking facing west, to resume its trip west. The train arrived at St. Louis, Missouri, and was handed to the Cotton Belt. For large portion of the journey over the Cotton Belt and Southern Pacific rains and flooding caused some delays. At Corsicana, Texas, the Southern Pacific took the train. A showing of SP power involving seven live locomotives took the train over Beaumont Hill.

At 5:40 PM on June 30, 1922, the train pulled to a stop in Los Angeles, California.

The train was then hauled to Los Angeles, California, reaching its destination on July 4, after covering 3,743 miles. The locomotives were taken to Exposition Park and displayed there for publicity purposes, viewed by thousands, then stored near the Park until called to service.

The post WW I depression era hit the Philadelphia/Chester area quite hard. The shipyards were largely closed, or reduced to

Building Inventory at Eddystone

Bldg No.	Building	Description & Notes
1	OFFICE	BUILT 1927 - 1928 Cruciform type, eight floors
2	CAFETERIA-1	BUILT circa 1924 - 1928 Capacity 800 people, full kitchen, separate dining rooms for men and women and large dining area for general use.
XX	CAFETERIA-2	BUILT circa 1917-1921 A smaller building was built near the Jacket and Pipe Shop for use by the workers in that northwest area of the complex.
3	ERECTING SHOP	BUILT circa 1912* 7.5 acres under roof. STEAM and ELECTRIC LOCOMOTIVES ASSEMBLED HERE
4	BOILER SHOP	BUILT circa 1915 This facility was part of the original Remington Arms Company plant used for the manufacture of rifles during WW I. It was connected with Building No. 24. The plant was converted to a true Boiler Shop circa late 1919. STEAM BOILER LAID OUT, FLANGED, ROLLED AND ASSEMBLED HERE. CAPACITY 50 BOILERS/WK.
5	CHEMICAL LAB	BUILT circa 1916 Chemical analysis of about everything used at Baldwin, part of the Quality Assurance function.
6	PHYSICAL LAB	BUILT circa 1916 Testing physical properties of steel, iron, probably some testing of finished components.
7	PATTERN SHOP	BUILT circa 1907 Woodworking Shop where all wooden models were made from drawings where a casting of brass, iron or steel were required. FOUNDRY PATTERNS AND EXPERIMENTAL MODELS BUILT HERE
8	PATTERN STORAGE	BUILT CIRCA 1924 - 1928 Storage for foundry patterns.
9	FOUNDRY	BUILT 1907 Appears to have expanded as orders for locomotives increased and a diversification into non-railroad castings evolved. By 1928 four units in place capable of molding sand, melting and pouring metal, shake-out and clean-up of castings. POURED IRON AND STEEL <u>ONLY</u> AT THIS LOCATION
10	SPRING SHOP	BUILT ??? Appears to have manufactured both coil and elliptical springs. Appears to have been phased out and handed to Baldwin's Standard Steel subsidiary. SPRINGS MANUFACTURED HERE
11	SMITH AND HAMMER SHOP	BUILT 1907 Every forged or hammered items was at least blanked out in this building and also at Building Number 15. Baldwin distinguished between smaller items and larger items, separating them into separate buildings. FORGED, UPSET AND HAMMERED BLANKS
12(D)	WHEEL AND AXLE SHOP	BUILT??? Large machine shop where driver centers, tires, wheels and axles were machined and assembled. Driving boxes machined and other miscellaneous machining operations. DRIVER SETS, OTHER WHEEL AND AXLE SETS AND DRIVING BOXES
13	BRAKE EQUALIZER SHOP	BUILT??? Machining of all locomotive brake rigging BRAKE RIGGING MANUFACTURED HERE
14(D)	BOX SHOP	BUILT??? Journal boxes and misc..
15	SMITH AND HAMMER SHOP	BUILT 1907 Every forged or hammered items was at least blanked out in this building and also at Building Number 11. Baldwin distinguished between smaller items and larger items, separating them into separate buildings. FORGED, UPSET AND HAMMERED BLANKS
16	WHARF AND PIER	BUILT 1915 Load and unload ocean-going vessels.
17	CYLINDER SHOP	BUILT 1916 Originally built for Eddystone Ammunition Company. Converted to cylinder machining after late 1921. MACHINED AND ASSEMBLED CYLINDERS
18	FRAME SHOP	BUILT 1916 Originally built for Eddystone Ammunition Company. Converted to locomotive frame machining after late 1921. MACHINED LOCOMOTIVE FRAMES
19	TANK (TENDER) SHOP	BUILT 1924 13.5 acre Complete shop to assemble tenders and all components, including painting. MANUFACTURED LOCOMOTIVE TENDERS
20	SCALE HOUSE	BUILT 1920 900 ton capacity weighed all locomotives.
21(D)	ERECTING SHOP	BUILT 1918 Probably where most of the heavier locomotives were assembled. All the components were brought together here and assembled into a completed locomotive. STEAM AND DIESEL LOCOMOTIVES ASSEMBLED HERE
22	MACHINE SHOP	BUILT 1921 This massive facility included 17 acre under roof.. It included a brass foundry, complete machining and finishing of drive rods, valves, pistons, motion work and a complete store room area. MACHINING OF ALL OTHER LOCOMOTIVE EQUIPMENT
23	POWER HOUSE	BUILT AFTER 1928 Steam and electric generation.

- 24 **BOILER SHOP BUILT 1915** This building had a long and colorful career. It was built as part of the Remington Arms Company Rifle Plant, and converted to part of the boiler shop at the end of 1919, or thereabouts. It appears to be where staybolts, syphons flues, tubes and superheater units were assembled.. It was later labeled for Medvale Steel Company and even later Southwark Division. **BOILER COMPONENTS MANUFACTURED HERE**
- 25 **TOOL AND DIE SHOP BUILT???** A precision machiner shop where the speciality tooling and all the dies used elsewhere were machined.
- 26 **HOSPITAL BUILT ???** Gone by 1928, this department moved to an undisclosed location in another building
- 27 **POWER HOUSEBUILT???** Steam and electric generation.
- 28 **POWER HOUSEBUILT???** Steam and electric generation.
- 29 **POWER HOUSEBUILT???** Steam and electric generation.
- 30 **PIPE & JACKET SHOP BUILT 1923** For locomotive piping and boiler jacket

(MAP ON PAGE 76)

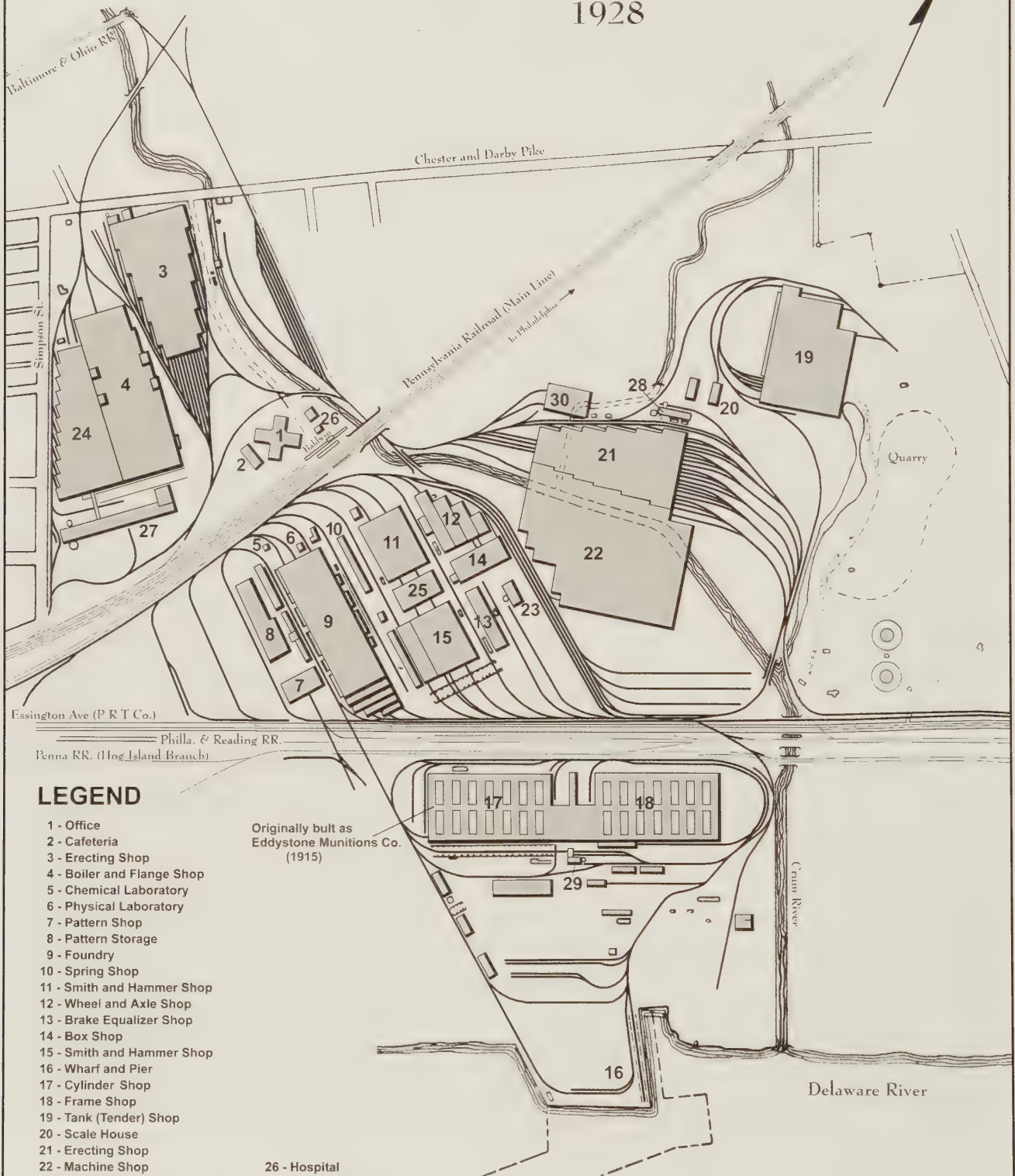


Baldwin Locomotive Works, Eddystone plant looking east. The first erecting shop is on the lower left and the boiler shop is the larger structure on the right. The office is in the center of the photo. The foundry and box shop is above the office. The second erecting shop is in the top left. The Pennsylvania Railroad main line is in the center of the photo. -- BLW Photo

THE BALDWIN LOCOMOTIVE WORKS

Facilities Map - Eddystone, Pennsylvania

1928



LEGEND

- 1 - Office
- 2 - Cafeteria
- 3 - Erecting Shop
- 4 - Boiler and Flange Shop
- 5 - Chemical Laboratory
- 6 - Physical Laboratory
- 7 - Pattern Shop
- 8 - Pattern Storage
- 9 - Foundry
- 10 - Spring Shop
- 11 - Smith and Hammer Shop
- 12 - Wheel and Axle Shop
- 13 - Brake Equalizer Shop
- 14 - Box Shop
- 15 - Smith and Hammer Shop
- 16 - Wharf and Pier
- 17 - Cylinder Shop
- 18 - Frame Shop
- 19 - Tank (Tender) Shop
- 20 - Scale House
- 21 - Erecting Shop
- 22 - Machine Shop
- 23 - Power House
- 24 - Midvale Steel and Ordnance Co.
- 25 - Tool and Die Shop
- 26 - Hospital
- 27 - 29 - Steam Plants
- 30 - Pipe & Jacket Shop

Originally built as
Eddystone Munitions Co.
(1915)

modest repairs, and tens of thousands were looking for work, or had left the region completely. Baldwin had laid off thousands of men, along with a significant number of women who had worked in both their defense plants and in locomotive assembly. Orders hit a low not seen since 1908 with just 515 steam locomotive orders and 169 electric locomotives, most of these being small industrial units.

In 1923 Baldwin began to quietly liquidate some of its wartime acquisitions, such as steel mills, iron ore deposits and allied supplier interests. It was flush with cash and found no need to immediately worry about its financial position.

The devastation in the economy of the Philadelphia area was beyond belief when the hometown Pennsylvania Railroad stepped forward with an order for 475 2-10-0 (11s) locomotives. It changed the economic picture for Baldwin and gave some sense of hope to some laborers who saw no end to the severe depression blanketing the region.

The locomotives, copies of the PRR version built at their Juniata Shops in 1916-1917, carried just a few changes and additions. The Baldwin locomotives would have Worthington feedwater heaters, Type "E" superheaters, stokers and power reverse gears. They retained their 62 inch drivers, 250 p.s.i. steam pressure and engine weight of 386,100 pounds. The Pennsylvania Railroad designed these locomotive with the Number 2, 3 and 4 drivers having blind (flangeless) driver tires.

Baldwin immediately began tooling up to produce the order, and just 57 days from the date the order was released for production, the first locomotive, PRR 4300 rolled out the doors at Eddystone. Baldwin placed air reservoirs on the pilot beam just under the smoke-box door, giving the locomotives a very distinctive look that closely followed the architectural lines of PRR locomotive styling. At its peak the Baldwin shop forces were able to turn out seven locomotives in a single day, the last time such a

feat would be accomplished at Eddystone. All 475 locomotives were delivered by the end of November 1923.

Baldwin was not unfamiliar with the 2-10-0 wheel arrangement, having manufactured its first of that wheel arrangement in 1902, and several hundred "Russian Decapods" for the Czarist Russian Government during WW I.

The PRR assigned Road Numbers 4225-4699 to the order. Baldwin records show the lowest construction number assigned to PRR Number 4300 c/n 55725 and dated November 1922. This locomotive posed for the official builders photos upon completion. The lowest PRR Road Number 4225 c/n 56561 was not completed until June 1923. Locomotives were delivered in groups of 10 to 20 per lot, usually every other week throughout the balance of 1922 and all throughout 1923. The last locomotive, PRR Number 4699 c/n 57317 was delivered in November 1923.

Baldwin offered its own lightweight 2-10-0s after World War I. Two designs were posted in the catalog, one weighed 250,000 pounds and a lighter locomotive weighed 212,000 pounds.

The last major manufacturing building constructed at Eddystone was the Tank Shop, (Tender) Shop, opened in 1924. It was a complete shop covering 13.5 acres and used to assemble tenders and all components, including painting. This move was significant to Baldwin because its tender shop at Broad Street was contained in a four story building and work in process was passed down from floor to floor as raw materials went to the upper floors to start assembly.

The tender shop was self-contained for every phase of tender construction. It was quite in contrast to tank construction at Broad Street. All material entered at the west side of the building and progressively moved toward assembly bays at the opposite side. Baldwin made a concerted effort to use all space efficiently to save excessive handling and wasted labor. The

Locomotive 60000

shop could build tanks of every size and shape from a large rectangular tank to a cylindrical Vanderbilt tank. Cast tank frames were brought in either from the Standard Steel Foundry and later, after 1931, from the General Steel Castings Foundry across Essington Avenue.

The trucks and brakes were assembled in a specified bay and met the tank at the appropriate time. Usually in less than a day a tender was mounted on the trucks and moved via an inside transfer table to the painting bay for completion.

Side sheets, end sheets, baffles and coal ways, or oil tanks moved over large the layout tables to the punching machines. One machine automatically spaces and punches the rivet holes and trims the edges. Portable riveters, acetylene burners and new electric arc welders fused the plates and shapes together. Riveting gangs completed each tender. Baldwin reported 250,000 rivets were driven weekly in the din of assembly.

Completed tenders were moved from the tank shop over to the erecting shop by plant locomotive when the locomotive was completed and ready for live-steam test.

By the end of 1924, the only work left at the Broad Street complex were the electric and industrial locomotive production some small amount of machining and the massive boiler shop. All boilers were assembled at Broad Street and shipped down to Eddystone through 1926, when gradually the tooling and crews were shifted down to Eddystone. There is no record to indicate when the 26th Street Finishing Shop was closed, though it was probably by 1921.

The boiler shop included the plate drilling, cutting, rolling, boiler assembly, flanging, riveting, installation of firebox, stays, flues and associated appliances. It was heavy work and not easily uprooted for movement to Eddystone.

Lima Locomotive Works, who had been an industrial locomotive builder, entered the Class 1 locomotive market in 1911. Their entry was barely noticed by either Baldwin or American Locomotive Company. An engineer formerly with Baldwin and American Locomotive, William Woodard came to be affiliated with Joel Coffin, who owned many key steam manufacturing industry holdings. Among them was Franklin Railway Supply, American Arch Brick, Superheater Company, Combustion Engineering and in 1916, his acquisition of Lima Locomotive Corporation, which he then reorganized as The Lima Locomotive Works.

Coffin and Woodard had their hands full trying to break into mainline locomotive markets that were steeped with tradition. Going against Baldwin they had to try and overcome the newest evolution being touted, that of the articulated locomotive. The end of the Vaucrain Compound had largely taken place by the time Woodard started a series of design changes to make the locomotive a much more efficient machine, evolving as Super-Power.

When Lima rolled out the A-1, a 2-8-4 Super-Power design in 1924, it changed, for the second time in just seven years the way railroads purchased and used locomotives. The Super-Power design was quite the reverse of Baldwin's traditional approach, which suggested that if a railroad wanted a more powerful locomotive, it had to be larger, suggesting articulation, even duplexing of the drive train. The traditional approach espoused by Samuel Vaucrain, did not recognize emerging steel alloys to replace iron, the high waste of BTU's of heat, the rising maintenance costs and the cost per horsepower.

The performance of Lima's A-1 shook Baldwin. The A-1 was touted widely for its sweeping success, a revolution for which Baldwin was ill-prepared. Railroads, who were on a roller-coaster for financial survival in the 1920s took

keen interest in the advantages of Super-Power thus eroding Baldwin's leading market position. Vaucrain responded with his own version of Super-Power, a 4-10-2 three cylinder water tube fire box locomotive.

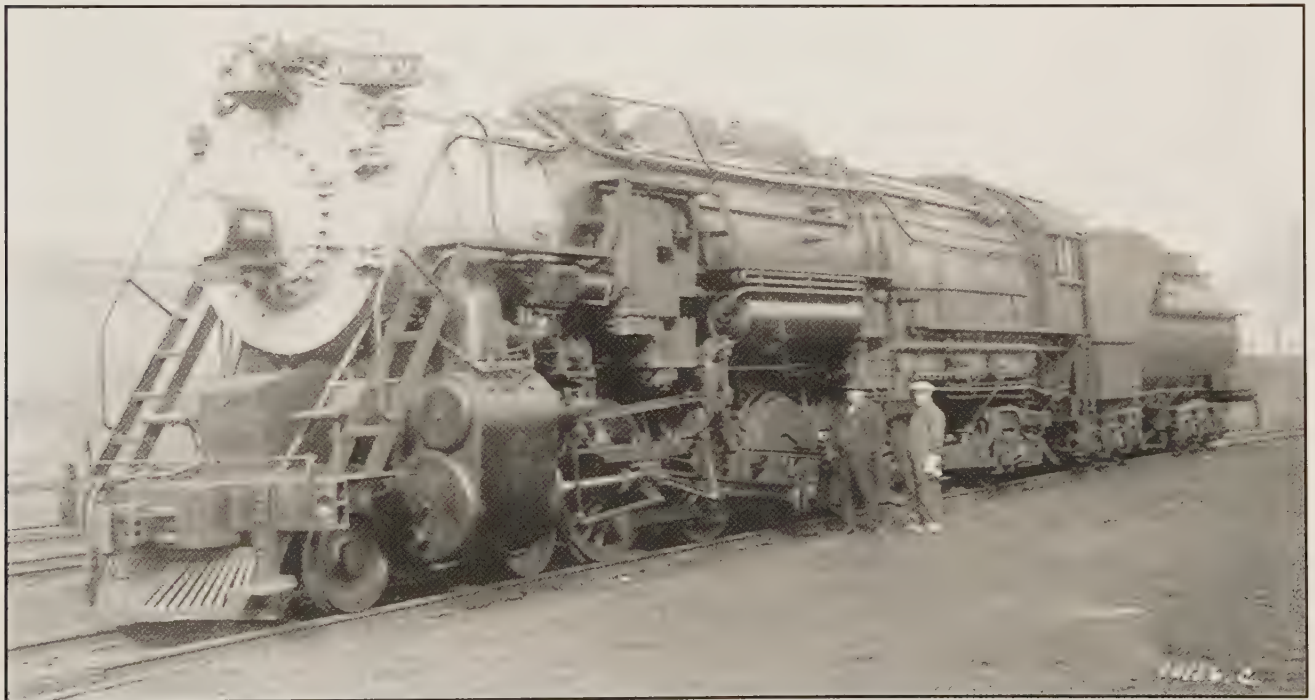
Baldwin had to rapidly respond with the development of its own version of Super-Power locomotive, adapting a Vaucrain type compound and a wagon-top water tube boiler. It was built during the early part of the year 1926, Baldwin claimed it was an experiment to ascertain the possible economies which can be effected by the use of high steam pressures and a high ratio of expansion. In reality it was to assure a shaky that market Baldwin would make a competitive response to Lima's Super-Power

Baldwin's locomotive design and development into the early 1920s brought with it mainly known and proven concepts, things understood by the railroads and their engi-

neers; an increase in weight of individual locomotives; an increase in power being proportionate to the increase in weight of the locomotive. Such increases in power made possible certain economies in train locomotive performance. With Lima's A-1 the demand for still further economies led Baldwin locomotive designers to strive to increase the efficiency of the next generation of locomotives, and thus give increased power per locomotive.

Traditional means adopted included the use of superheated steam, various fuel and labor-saving devices, such as the stoker, better boiler water preheating, improvements in boiler design, more efficient steam distribution, and refinements in design and materials for locomotive parts, such as steel in place of iron for cylinder castings, alloy steel drive rods and furnace design that could in theory generate more steam than the locomotive could use.

Baldwin gave focus to the possibility of



Baldwin Locomotive 60000, an experimental three cylinder 4-10-2 was Baldwin's response to the introduction of *Super-Power* by Lima Locomotive Works in 1925. It was not well received during demonstration and any significant maintenance required much tear down of equipment to effect repairs. -- BLW photo

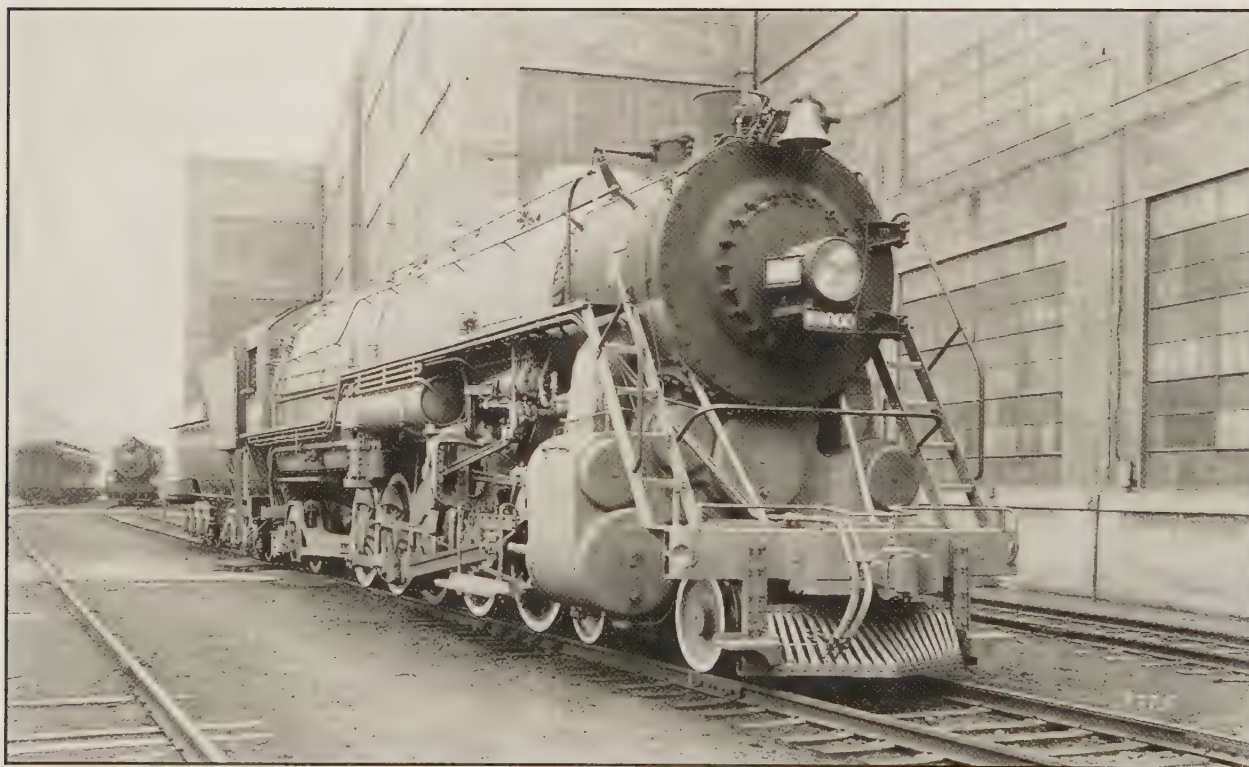
using a higher boiler pressure and to thus give greater cylinder efficiency and consequently greater horsepower. The advantage of high pressure steam is that a combination of adequate cylinder force and high ratio of expansion could be obtained with cylinders of moderate dimensions.

Engineering thinking at Eddystone of that day supposed there were limits set to steam temperatures by the method of producing the steam. It was a traditional view of locomotive designers in the 1920s, and thus Baldwin used a different approach to designing the 60000. The designers used as a means of obtaining the higher expansion necessary to give economy with steam of 350 p.s.i., three cylinders compounded, the high-pressure steam being first admitted to the middle cylinder. After expansion there, the steam passed through the receiver in the cylinder saddle to the two outside cylinders where further expansion took place. It was a near-fatal trade-off

because it immediately imposed a higher maintenance penalty for the poor-access middle cylinder and push-rod assembly.

Baldwin engineers suggested a working steam pressures of 240 and 250 p.s.i. as probably about the maximum pressure that could be carried in boilers of the conventional radial stay design fireboxes having flat sides braced by staybolts. The stayed firebox is the weakest point in a locomotive as ordinarily designed, and with pressures carried above 250 pounds per square inch a change in design was necessary to eliminate excessive trouble with staybolt breakage. Baldwin, in its decision to use a pressure of 350 p.s.i. in Number 60,000 elected to use a water tube firebox, and the eliminate all staybolts.

On paper the locomotive was to be of the 4-10-2 type, built for freight service, with driving wheels 63.5 inches in diameter, and three cylinders each 27 inches in diameter by 32 inches stroke. The total weight in working was



Sitting inside the Eddystone plant a brand new Baldwin Locomotive 60000 awaits the start of road testing, which took it all the way to the west coast and return. It was not well received and was parked back at Eddystone and used as a mobile stationary steam plant until donated to the Franklin Institute in Philadelphia.-- BLW photo

General Dimensions and Weights for BLW 60000

CYLINDERS

High-pressure (1), inside	27" x 32"
Low-pressure (2), outside	27" x 32"
Valves	Piston, 14" dia.

BOILER

Type	Wagon top
Diameter	84"
Working pressure	350 lb.
Fuel	Soft coal

Firebox

Type	Water-tube
Length, total	199.5"
Width, total	96"
Length of grate	138.25"
Width of grate	86"
Water-tubes, number	100
Water-tubes, diameter	4"

Boiler Tubes

Diameter	5.5"	2.25"
Number	50	206
Length	23'0"	23'0"

Heating Surface

Firebox	745 sq. ft.
5.5" flues	1645 sq. ft.
2.25" tubes	2775 sq. ft.
Firebrick tubes	27 sq. ft.
Total	5192 sq. ft.
Superheater	1357 sq. ft.
Grate area	82.5 sq. ft.

DRIVING WHEELS

Diameter, outside	63.5"
center	56"
journals, main	12" x 13"
others	11" x 13"

ENGINE TRUCK WHEELS

Diameter, front	33"
Journals	7" x 12"
Diameter, back	45.5"
Journals	9" x 14"

WHEEL BASE

Driving	22' 10"
Rigid	16' 9"
Total engine	45' 2"
Total engine and tender	86' 11.25"

WEIGHT in working order

On driving wheels	338,400 lb.
On truck, front	57,500 lb.
On truck, back	61,600 lb.
Total engine	457,500 lb.
Total engine and tender	700,900 lb.

TENDER

Wheels, number	12
diameter	33"
Journals	6" x 11"
Tank capacity	12,000 U. S. gal.
Fuel	16 tons
Tractive effort	82,500 lb

calculated at 457,500 pounds, of which 338,400 was on driving wheels.

Apart from the modifications necessary to the use of the water-tube firebox and the high pressure, the boiler did not differ in principle from that of the radial stay type firebox locomotive. The boiler barrel was of the usual firetube type having 206 2.25 inch tubes and a type A superheater

carried in 50 5.5 inch flues.

The boiler barrel consisted of three courses, having plate thickness of 1 5/16", 1 3/8" and 1.5" respectively. The third course was tapered on top, increasing the shell diameter from 84 inches at the front end to 94 inches at the back. All circumferential seams were double riveted, and the longitudinal seams being the octuple riveted

DIMENSIONAL COMPARISON BLW 60000/ LIMA A-1

CYLINDERS (inches)	60000	A-1
High-pressure (1), inside	27 x 32	--
Low-pressure (2), outside	27 x 32	28 x 30
Piston Valve	14"	14"
BOILER		
Type	Wagon top	Wagon Top
Diameter	84"	94"
Working pressure	350 p.s.i.	240 p.s.i.
Fuel	Soft coal	Soft coal
Firebox		
Type	Water-tube	Standard radial stay
Length, total	199.5"	150.12"
Width, total	96"	96.25"
Water-tubes, number and diameter	100@4"	--
Boiler Tubes		
Number and size	50@5.5"	90@2.25"
	206@2.25	204@3.5"
Heating Surface*		
Firebox	745 sq. ft.	284 sq. ft.
5.5" flues	1645 sq. ft.	3,718 sq. ft.
2.25" tubes	2775 sq. ft.	1,055 sq. ft.
Firebrick tubes	27 sq. ft.	--
Arch tubes	--	53 sq. ft.
Total	5192 sq. ft.	7,221 sq. ft.
Superheater	1,357 sq. ft.	2,111 sq. ft.
Grate area	82.5 sq. ft.	100 sq. ft.
DRIVING WHEELS		
Diameter, outside	10@63.5"	8@63.0"
ENGINE TRUCK WHEELS		
Diameter, front	4@33"	2@33"
Diameter, back	2@45.5"	4 total
WHEEL BASE		
Driving	22' 10"	16'9"
Total engine	45' 2"	
Total engine and tender	86' 11.25"	
WEIGHT in working order		
On driving wheels	338,400 lb.	248,200 lb.
On truck, front	57,500 lb.	35,500 lb.
On truck, back	61,600 lb.	101,300 lb.
Total engine	457,500 lb.	385,000 lb.
Total engine and tender	700,900 lb.	660,000 lb.
TENDER		
Wheels, number	12	12
diameter	33"	33"
TRACTIVE EFFORT		
Engine	82,500 lb.	69,400 lb.
Booster	--	13,200 lb.
Total tractive effort	82,500 lb	82,600 lb.

design, which provided a short caulking distance between the rivets. At the rear, the barrel was closed by a tube sheet, which was riveted to the shell in the same manner as the front tube sheet. The boiler tubes and flues were welded into the rear tube sheet. None of the studs tapped into the boiler passed all the way through the sheets, hence there could be no leaky studs or stays.

Two steam drums are each 26 inches in diameter, and the transverse distance between their centers is 31 inches. They have a total length of 23 feet 6 inches, and extend into the boiler barrel a distance of 5 feet 6 inches ahead of the back tube sheet. The openings in this sheet, through which the drums passed, have flanges $6 \frac{5}{8}$ inches in depth, to which the drums were double riveted. Each drum was closed, at the rear, by a cover plate which was secured to an internal ring by means of studs, and was fitted with a copper gasket to keep the joint tight. By removing these covers the drums could be entered for purposes of inspection, and removal of any scale.

The third course in the boiler barrel was tapered on top, and the two upper drums were so located that their forward extensions come in contact with this course and are riveted to it. This acts as a support for the drums, and tends to counteract the cantilever effect of the long

overhanging firebox. Furthermore, to balance the effect of the pressure on the covers at the back ends of the drums, three longitudinal stay rods are run from the forward end of each drum to the front tube sheet. These rods were anchored to internal braces which are riveted to the drum. This construction, together with a system of braces connecting the front end of the mud-ring and the boiler barrel, relieved the back tube sheet of any tendency to distortion, due to the firebox overhang and the pressure on the drum heads.

The locomotive used a hollow cast steel mud-ring, connected to each upper drum by 48 tubes each 4 inches in diameter; and there were four tubes connecting the drums to the back section of the mud-ring. All these tubes were swaged to a diameter of 3 inches at the mud-ring end, where they were rolled and belled, while at the drum end they are rolled, belled and welded. The tube holes in the mud-ring had two depressions rolled into them, into which the tubes lock themselves firmly when being rolled in. Water connections between the bottom of the boiler barrel and the front end of the mud-ring was made by two elbow pipes, each 9 inches in diameter, and placed right and left.

The mud-ring, which had a total length of 18 feet 2 inches and a width of 8 feet 5 inches, is cored throughout to permit water circulation. The



The Baldwin Locomotive Works Locomotive 60000 on temporary track at the Franklin Institute on September 27, 1933. It is the only locomotive to go directly from its builder to a museum for display



A view of the 60000 as it is about to enter into the exhibit area at the Franklin Institute at Philadelphia on September 27, 1933.

rectangular outer frame was crossed by a central longitudinal member and also by a transverse member located about six feet back of the front end of the firebox. From this transverse member, which lies at the front end of the grate, five water tubes extended to the upper drums, and served as supports for the brick arch. That portion of the firebox which was forward of the arch constituted a combustion chamber and was closed, at the bottom, by a horizontal steel plate, and floored with firebrick. A Y-shaped cinder pocket was applied for cleaning this combustion chamber.

The locomotive was arranged for burning stoker, coal, and was equipped with a Duplex stoker. It was converted to operate as an oil burner while in demonstration on the Southern Pacific Railroad.

The three cylinders, with their steam passages and steam chests, were formed in a single grey iron casting. The high-pressure steam chest was placed in the saddle, on the

right-hand side, and was connected with the superheater by a single steam pipe. All the piston valves were 14 inches in diameter, that for the high-pressure cylinder being arranged for inside admission, while the valves for the low-pressure (outside) cylinders were arranged for outside admission. The high-pressure exhaust steam was conveyed to the low-pressure steam chests through passages cored in the cylinder casting. The exhaust from the low-pressure cylinders passed to the smokebox through outside pipes which terminated at a single exhaust nozzle. A Worthington feedwater heater was applied to this locomotive, and a branch from each exhaust pipe conveyed steam to the heater.

For starting purposes, live steam was admitted to the low-pressure cylinders through a 1.5-inch pipe leading from a manually-controlled valve in the cab. This created a back pressure on the high-pressure piston, relieving the same from the full effect of 350 pounds' pressure.

Crank axle and wheels were the second pair of driving wheels, the outside cylinders being connected to the third pair. The axle was built up of five pieces.

The two outside cranks were placed 90 degrees apart, so that there were four even exhausts per revolution, and the inside crank placed at 135 degrees from each outside crank. The high-pressure piston was connected to the second pair of driving wheels, and the two low-pressure pistons to the third pair. All three piston heads were of the built-up type, with spiders of cast steel. The main and side rods were of carbon vanadium steel, while the driving axles, main crank pins and piston rods were of open hearth steel, heat treated, oil quenched and hollow bored.

Walschaerts valve gear was used, with an independent motion for each cylinder, but all controlled by a Type B Ragonnet power reverse gear. The valve for the left-hand cylinder was operated from the left-hand main pin and crosshead in the usual way. The right-hand valve received its lead from the right-

hand crosshead, but the link for this cylinder was operated through a transverse shaft, by means of a connection to the left-hand crosshead. The return crank on the right-hand main pin was set to operate the valve for the inside cylinder, and this valve was given lead through a connection with the inside crosshead.

Locomotive 60000 was designed to traverse curves of 17 degrees, having flanged tires on all the wheels. Lateral motion boxes were applied to the first driving axle. The front truck had a swing bolster suspended on heart-shaped links, while the rear truck was of the Delta type, and was so designed that a booster could subsequently be applied if necessary. There was a continuous equalization system on each side of the locomotive, from the leading drivers to the rear truck.

All accessories were operated by superheated steam at a pressure of 350 pounds, except the feedwater heater and injector, which use saturated steam.

The tender was carried on two six-wheeled trucks, and of the Vanderbilt type with capacity for 12,000 gallons of water and 16 tons of coal. Oil tank capacity was not stated

Preservation of Locomotive 60000

After a disappointing performance on the Southern Pacific Railroad in the Sierra-Nevada mountains, Locomotive 60000 was returned to the East in 1927. Experience showed that the economies gained by the compound cylinders were offset by higher maintenance costs and more frequent breakdowns. Some suggested the axle loadings on 60000's driver wheels were too heavy for the average roadbed, others indicated the wheel base was too rigid.

Lima Locomotive Works was stealing a weak locomotive market right out from under Baldwin with its highly successful Super-Power design and the A-1. It offered near identical performance without compounding, and with one less set of drivers. With refinements to the boiler and

firebox it generated more steam than the locomotive could use, and burned coal more efficiently.

Locomotive 60000 was retired from further use and herded along side one of the buildings at Eddystone to be fitted with a steam pipe and relegated to sporadic use as a stationary boiler. It is thought that about 1932, Samuel Vauclain, sought to rescue the locomotive and donate it to the Franklin Institute in Philadelphia. Vauclain was on the Board of Trustees of the Franklin Institute. George Houston gave his nod. The locomotive was readied for its last main line trip on any railroad. It was not restored and received no attention while awaiting movement from Baldwin to the Franklin Institute.

On September 27, 1933, as The Franklin Institute's new science museum was nearing completion, a crowd of curious onlookers gathered to watch a remarkable sight.

The John Eichleay Jr., Company, movers contracted the moving of the locomotive. This was a complicated process. The locomotive and connected tender were placed on a temporary steel deck and secured. Because of the concentration of weight on the streets, the contractor placed heavy planks on the street and built two narrow gauge tramways on ties over which moved the locomotive. The tracks were stepped, whereby a few lengths of rail were placed in front of the locomotive and those having been rolled over were taken up and moved to the front. The slow journey started at 30th Street Station and moved down the Benjamin Franklin Parkway to 21st Street and through an opening in the northwest corner of the building.

Progress was necessarily slow and it required the better part of a week to complete the job. The cradled locomotive was pulled slowly along. Complicating the move, several major streets had to be crossed, which carried both trolley lines and heavy automobile traffic. Those intersections were crossed late at night or in early morning hours when travel was at a minimum.

Upon reaching the display building, it took a day before it was completely inside the new

exhibit area. Then the open wall was sealed. The locomotive has remained there ever since, traveling 12 feet forward and 12 feet back many times each day.

The Caprotti Poppet Valve Gear

In 1911, thirty-year-old Arturo Caprotti, a student of automobile engineering at Milan University, (Italy) was told by his tutor that the steam railway locomotive was the most inefficient machine. That was an understatement. Caprotti, who understood the poppet valve arrangement of the gasoline engine began looking at the problems associated with the steam locomotive slide valve and the newer spool valve that controlled the admission and exhausting events of steam. He also studied the valve rod mechanism and decided much of the conventional mechanism could be miniaturized while maintaining sharp control on the admission and exhausting of steam.

Over four years he came up with an automotive style valve gear that was a radical departure from accepted steam conventions. The idea was to obtain better use of steam through precisely timed valve events over a broad range of operating speeds and thus gain improved locomotive performance and fuel economies. The idea was correct, the complexities of the machinery were another story.

Caprotti's poppet valve was filed for patent in the United States on October 22, 1921. (*Granted August 11, 1925, US Patent 1,549,712*). The valves admitting steam into the cylinders being operated by cams on a rotating camshaft. Drive for the camshaft was taken from the driving wheels, by means of gears and a small drive shaft.

The realization of Lima Locomotive's highly successful Super-Power and the failure of the Baldwin Number 60000 brought Sam Vauclain and Harry Glaenzer to explore the new invention of the Caprotti poppet valve. In short order Baldwin was licensed to build the

Caprotti valve gear in the United States. Their first proposal for application to a locomotive was to that of the Baldwin Number 60000. After some months of engineering, Glaenzer and Lawrence Hance filed for a patent to cover a three-cylinder compound poppet valve locomotive, application made July 14, 1927 and granted on May 28, 1928 as US Patent 1,671,821. The patent was never built, instead it used spool valves and the BLW 60000 was retired to become a portable stationary steam plant at Eddystone.

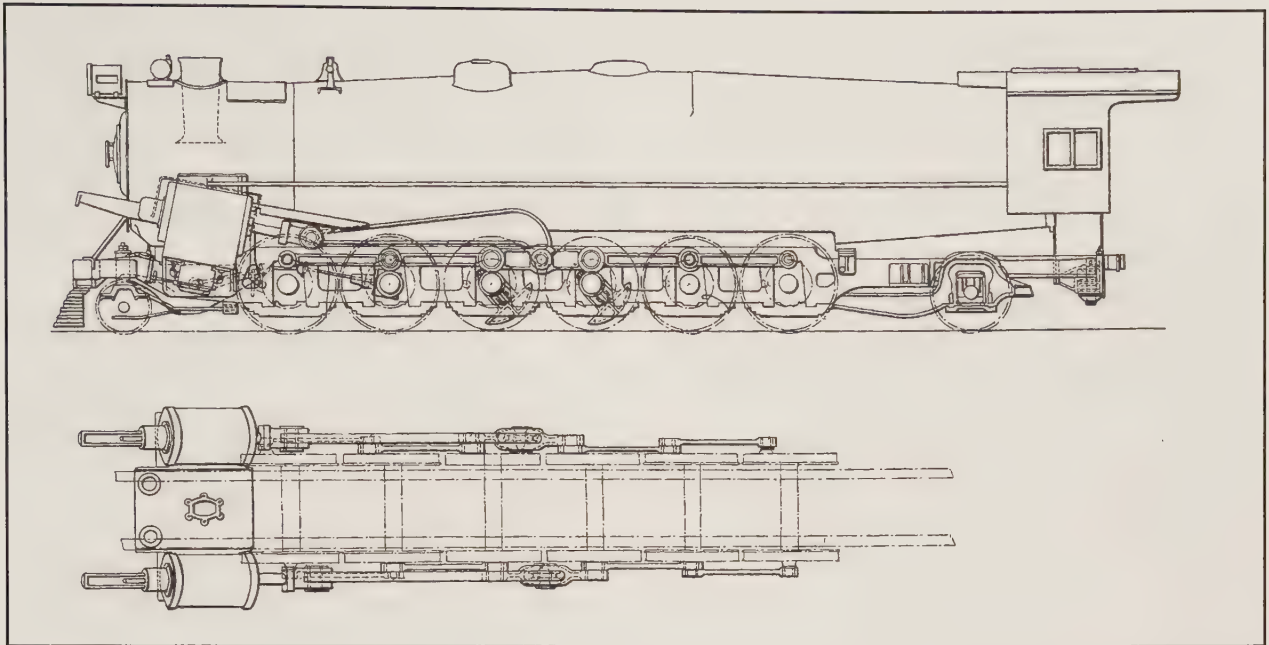
Caprotti poppet valve gear was applied to Baltimore & Ohio 2-8-0 No. 2722, in March 1927. The preliminary tests suggested the valve gear needed additional refinement to stop valve slapping. Baldwin began advertising the Caprotti poppet valve gear as offering "important savings" but there was almost no interest.

The B&O built 4-6-2 No. 5320, *President Cleveland*, during 1928 at their Mt. Clare Shops in Baltimore, Maryland and equipped it with Caprotti poppet valve gear, but it was not successful and the valve gear was replaced just one year later.

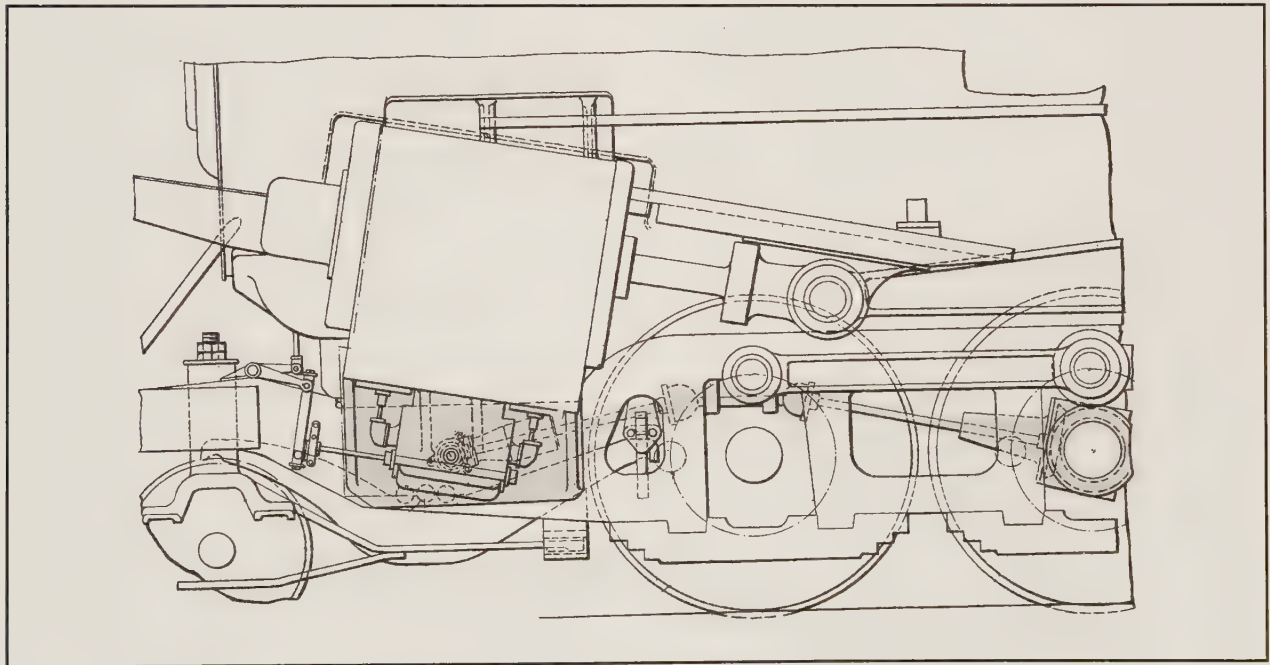
Baldwin was pushing for a steam locomotive with 1,000 horsepower per drive axle and in 1929 promoted the concept of a 2-12-2 for the Pennsylvania Railroad utilizing the Caprotti poppet valve gear, a large sloped cylinder assembly and under-saddle mounted cam box. The Caprotti poppet valves eliminated the flailing side and eccentric rod assemblies, thus Baldwin also proposed an in-line main rod with a unique connection between the third and fourth axles on the side-rods. The idea was patented by Same Vauclain and Harry Glaenzer on June 17, 1930 as US Patent 1,765,251.

The PRR had a K5s built with Caprotti poppet valve gear in March 1929, Baldwin c/n 60660. It was reportedly used until 1937 when the valve gear was changed to Walschaert valve gear.

The PRR did not act further on the topic until 1939, when it had newly designed Franklin poppet valve gear placed on PRR 4-6-2 Number 5399 at Lima Locomotive Works.



Caprotti Poppet Valve Gear on a proposed 2-12-2 locomotive for the Pennsylvania Railroad. The locomotive was never built but the PRR eventually tried the poppet valves and installed the Franklin Railway Supply version on most of their fleet of T-1 locomotives.



Unique to the caprotti proposal was the sloped cylinder casting with the overhook push rod. The valve gear was placed between the two cylinders. The goal was to make a locomotive of 1,000 horse-power at each axle. Baldwin was the American agent for the Italian-built Caprotti Poppet Valves.

The Reading tried Caprotti valve gear on two of its locomotives, a 2-10-2 Number 3010 and 4-6-0 Number 616 circa 1929-30. The Southern Pacific retrofitted 2-10-2 Number 3769, BLW c/n 57947 with Caprotti valve gear circa 1929, but it was not repeated.

The last of the Caprotti poppet valve gear equipped locomotives was c/n 61091 a 4-8-4 built for the Atchison, Topeka & Santa Fe #3764 in September, 1929. It was the last of an order of four 4-8-4s. The Caprotti valves cost \$1977.73 more than the standard Walschaerts valve gear for this locomotive. It left the factory at Eddystone with Caprotti poppet valve gear.

While the valve gear might have offered some savings, the Santa Fe did not find it so, noting increased coal consumption. It was quickly realized the new valve gear required specialized maintenance personnel and that the valve gear was not heavy enough for the demands placed on it by the railroad.

The Caprotti valve gear was removed and new cylinders with Walschaerts valve gear was applied in 1934.

Mr. Caprotti continued to refine his inven-

tion, filing two more patents before his death in 1938, but was too late for Baldwin and by 1939 it had dropped the Caprotti poppet valve gear from its product line. When the first two prototype Duplex 4-4-4-4s were built for the Pennsylvania Railroad in 1942, they were equipped with Franklin poppet valve gear.

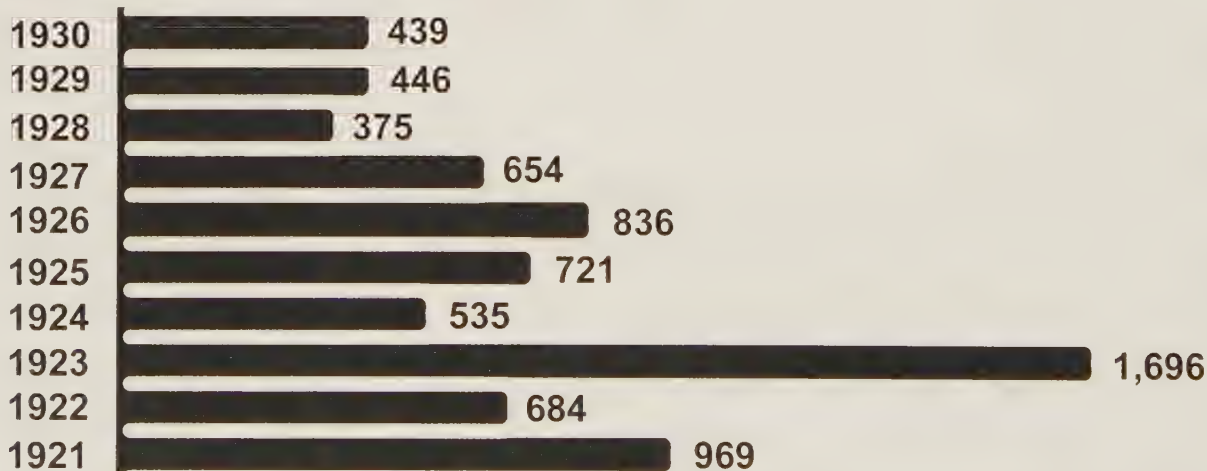
A Hostile Takeover

The price of Baldwin's stock in the first twelve years after the initial public offering caught the attention of many desiring good dividends and to make a profit on any stock sales. Perhaps it was the continued construction of a new complex at Eddystone, or the large orders received in 1923 that gave it the false illusion of being nearly depression proof.

In February 1927, Baldwin Locomotive Works announced 1926 performance and a profit of \$3,811,253 on sales of \$47,891,668. This bested the mediocre 1925 sales of \$27,876,064 and a very small profit of \$196,564.

Queries about Baldwin stock found them

Baldwin Locomotive Orders 1921 - 1930



Vauclain walked a precarious path during the 1920's as locomotives orders fell off. He had to maintain three facilities while he barely had orders enough to support the expense of Eddystone. It took production of 600 locomotives annually to cover expenses at Eddystone alone. The Board of Directors granted themselves lucrative stock dividends, draining the cash reserves then succumbed to a hostile take-over by the Fisher Brothers.

consistently reporting, "... only 200,000 shares of Baldwin stock exist, and a large part of these are held by officers, directors and others who wish to keep it off the market." As the Roaring 20's drew toward a close, this may have been an illusionary and perhaps misleading statement.

These kinds of statements caught the attention of a special group including two of Wall Street's "Big Ten," Detroit's Fisher Brothers* and Chicago wheat trader Arthur W. Cutten's pool syndicate. They took an especially strong interest in Baldwin, and began buying stock en masse by 1926.

It was in the year of 1926 that Baldwin had nearly completed the move of its manufacturing from Broad Street down to Eddystone. The move had overrun the best cost projections by a staggering sum, more than \$16 million. Worse, Eddystone was running at less than 27% of capacity after such heavy investment.

Stockholders were demanding high quality dividends and Vaucrain was gutting the treasury to appease them. His philosophy: "Building Locomotives is my only hobby," may have become an impediment considering Baldwin's significant decline in the six prior years.

The Fishers and Cutten at the same time made separate and significant moves on Baldwin. The Fishers in a hostile takeover attempt and Cutten with stock manipulation. Baldwin Locomotive Works management was under siege from the very circles of finance it had relied on for funding of its capital expansion projects at both Broad Street and Eddystone.

The Fisher Brothers and Cutten went after Baldwin stock with a vengeance. These two entities were part of an elite group of the world's most successful financiers. Along with eight other investors they were of extreme wealth and influence. They controlled more wealth than there was money in the U.S. Treasury during the mid-1920's. Cutten, the Fishers, and the others of the group were large

holders of particular stocks, counted in that portfolio of holdings were United States Steel, General Electric, Montgomery Ward, Baldwin Locomotive and others.

The Fisher Brothers had become wealthy through their automotive body manufacturing and the ultimate sale of their Fisher Body Works to the growing automotive conglomerate, General Motors Corporation of Detroit, Michigan. Three of the Brothers, Fred J., William A. and Edward F. sat on the Board of Director of General Motors. Three of the other four brothers were employed by GM in management positions. Through Fisher & Company, their investment and holding company, they controlled investments well in excess of two hundred million dollars.

Arthur W. Cutten of Chicago, was the recognized leader of the bull traders in the 1920's. Cutten, who started as a grain trader, had amassed an estimated 100 million dollars or more, in the stock market during the period of 1926-1929.

Various accounts hold that to an unknowing person Cutten, might have been mistaken for a country store keeper. He cared nothing for conventions, appearances or customs. Shy, quiet and unassuming, he was variously observed in the corner of a Pullman smoking room listening as casual travelers discussed his stock market feats unknowingly being observed by the financier. When not attending to his businesses, he was a gentleman farmer on his estate near Chicago.

By August of 1927, the Fishers held 120,000 of 200,000 shares of Baldwin common stock. It is not known whether they were shares sold off by the officers and directors of Baldwin or from another undisclosed investor. Cutten's holdings were not disclosed because of the way in which he traded stocks.

The Fishers, through their agents, C. R. Bitting and R. P. Shields of Detroit, traveled to

*The Fisher Brothers, born in Norwalk, Ohio, and successful in the automotive body business at Detroit included: Alfred J., Charles T., Edward F. Frederic J., Howard A., Lawrence P., and William A.

Philadelphia and on August 25, 1927, inspected both properties at Broad Street and Eddystone. With that complete, they went to the Broad Street general offices and held a private meeting with Baldwin President Samuel Vauclain and Chairman, Thomas S. Gates. The outcome of that meeting indicates the two demanded to attend the monthly Board of Directors meeting for the intended purpose of being seated on the Board to protect and represent the Fishers interests.

Vauclain and Gates, now certain of a hostile takeover, quickly and publicly pointed out that Baldwin common stock held no voting rights. The Fishers and Cutten owned a majority of that stock, they held no Baldwin preferred stock and therefore were theoretically not entitled to any seat on the Board of Directors.

Vauclain called off a scheduled Board meeting, claiming a quorum could not be present, sending Bitting and Shields away. They went to New York City, leaving word that if there was a Board meeting, they wished to be notified. Vauclain immediately called a Board meeting and conducted extensive affairs, which were not reported to the press. At the start of the meeting, word was sent to New York, offering no time in which Bitting and Shields could travel down and attend. They both expressed, "surprise and were somewhat upset."

The *Philadelphia Record* went on to say, "*The prize for which Fishers, Mr. Cutten and Mr. Vauclain have waged a three-cornered fight, which is now merely a Fisher-Vauclain bout, is said to be the \$30,000,000 of Center City real estate on which are the locomotive plants.*"

Arthur Cutten expressed no interest in entering into a fight with Vauclain and opposed Fisher's efforts. He made no strong attempt to push for a Board seat.

Cutten and his six Chicago speculators formed a syndicate pool and in the closing months of 1926 went after Baldwin stock for short-term profits. During November of that year Cutten's group took more than \$10 mil-

lion in profits through their various operations in Baldwin stock. On November 1, it opened at \$117. By December 3 just over a month later it was selling at \$165. By early 1927 it had climbed to \$230 per share.

Wall Street opinion suggested the Cutten syndicate would make no attempt to corner the market and there would be no attempt to control Baldwin or have anything else to do with it, except garner profits from the rise in stock prices.

Between January 1, 1927, and August 27, 1927, Cutten took another \$24 million through stock operations.

During the takeover attempt, Vauclain explained to a reporter from the *Philadelphia Record*, "*The only thing in which I am really interested in is the sale of locomotives.*" The record for Baldwin holdings suggests otherwise. The day after the September 1927, Board meeting Vauclain and Gates were still in control of Baldwin. The stock speculators had anticipated news of a successful takeover by the Fishers, but came off disappointed. Baldwin stock dropped \$14 at the lack of expected news. Locomotive orders continued in a long decline.

Baldwin was worth more in the financial paper world than it was as a capital equipment and locomotive manufacturer. In the year 1927, the profits derived by the traders of Baldwin stock had drawn off in excess of \$24 million while the firm's profits on the sales of locomotives were just over \$3 million.

The Fisher brothers remained determined in their efforts to gain control of Baldwin, having their agent, George H. Houston, successfully seated on the board. After a battle of endurance the Fisher Brothers scored a key victory, gaining controlling interest in The Baldwin Locomotive Works. It was early September 1927, when Vauclain finally admitted the Fishers had gained control of the common stock. At the November 1927 Baldwin Board meeting three new seats were authorized for the F. J. Fisher, Carl Bitting and Arthur Cut-

ten. Baldwin was destined for a different direction.

With the Fisher Brothers holding a large stock interest, they prepared for a complete readjustment of the capital structure of the Baldwin Locomotive Works in consequence of the purchase of a large stock interest in the company and the preparation of two plans of financial reorganization by engineers acting in behalf of the Fisher interests.

At the Board of Directors meeting March 28, 1929, Mr. Samuel Vaucain was elevated to the newly created position of Chairman of the Board. George H. Houston, was installed as president, the first outsider not groomed to the purpose of the locomotive builder by longstanding employment. Interests close to the General Motors Corporation were inclined to discredit reports that the election of Fred J. Fisher and Clarence R. Bitting to the directorate of the Baldwin Locomotive Works foreshadowed a new "community of interest" between General Motors and Baldwin.

George Houston had been associated with the Fisher Brothers as a technical adviser for several years. His background was in the field of reorganization and management of industrial concerns. He was not a railroad supply executive and quickly demonstrated his lack of knowledge in that field.

Closing The Broad Street Shops

By the end of 1925, Baldwin recognized that with the decline in new orders it could not sustain operations at the Broad Street Locomotive Plant, the 26th Street Finishing Plant and at a partially filled Eddystone facility. The decision was made to expend about \$10 million and complete the move.

A brief newspaper article dated January 2, 1926, provides a glimpse into beginning the final move. *"The Baldwin Locomotive Works had begun moving its boiler shop from its Broad Street plant to Eddystone. This is the*

starting of one of the biggest jobs in connection with company's removal program, which is expected to cost in its entirety \$16,000,000. Five years hence it is expected, by officials, all the company's manufacturing activity will be centered at Eddystone, where at present 65 percent of its locomotive-building activities are located."

By May 1927, rumors were flying that the Pennsylvania, the Baltimore Ohio and the Reading Railroads were about to buy the Philadelphia property of the Baldwin Locomotive Works for \$30 million. The railroad presidents quickly denied the rumors. The property was overpriced.

The Eddystone Rifle Plant building was gutted of its upper floors and thousands of feet of line-shaft, belting and thousands of rifle manufacturing tools as movement of the boiler shop began. The move required moving gang drills, plate cutters, shears, rolls and riveters, along with the installation of heavy overhead cranes and smaller jib cranes. Tracks were required to be installed in the plant to handle the movement of work in-process. All of this had to be accomplished without any disruption to the production schedules, which were quickly showing a loss of new locomotive orders. Before the year was out, locomotive production would hit a low of 10 percent of capacity and in a rebound, would only come up to 25% of capacity, which would not cover fixed costs.

While the boiler shop was being moved, plans for a new office building were being put on paper by Baldwin's Architect, Simon and Simon of Philadelphia. The building, eight stories was designed as a cruciform with four wings tying into a central tower. It was laid out so that those departments with closest contact with the shops occupied the ground floor, and those departments having less contact with manufacturing would occupy the higher floors, with administration on the top floor. The corner stone for the building was laid on December 7, 1927, by board member Edward T. Stotesbury. General con-

tractor was Turner Construction Company of Philadelphia.

The completed building overlooked a powerful expanse of machinery and people. Billions of dollars of deals were to be made and assets were spread across the land as far as the eye could see.

On June 28, 1928, Samuel Vauclain, surrounded by 4,000 onlookers dedicated Eddystone. James J. Davis, Secretary of Labor and Judge Albert Dutton MacDade also spoke at the dedication.

Vauclain, in his address spoke of the firm being in a time of depression, but that better times were ahead.

Executive offices were moved to the Fidelity-Philadelphia Trust Building at Broad and Walnut Streets.

Later Vauclain traveled north to Philadelphia and formally locked the doors on his old office and complex at 500 North Broad Street. That facility was put up for sale on July 2, 1928, but lacked any buyer for fifteen years. At least part of the property was purchased by Triangle Publications, parent of the *Philadelphia Inquirer* newspaper, on October 13, 1943. The physical plant had been demolished before that date.

By 1932 the Great Depression had set in. There were thousands out of work and homeless on the streets of Philadelphia. While Baldwin sought a property buyer, they eventually opened one of the Broad Street buildings as a homeless shelter in a gesture of civic compassion. They were the only major employer to take mercy on the less fortunate.

A Plan for Diversification

Baldwin's bellwether years were rapidly coming to a close. The Fisher Brothers now firmly in control of the direction for Baldwin was being guided by 46 year-old George Harrison Houston, the man picked to protect the interests of the Fishers.

Houston came into the organization against the desires of the Baldwin Board and at a time when the organization was near financial collapse. It was the first time a Baldwin President had come to the position without prior experience or coming through the ranks at the Locomotive Works. It was also the first time an outsider to the railroad industry came to the position. Did Houston have the important knowledge and understanding of Baldwin's clients, the world's railroads, to understand the important cyclic trends and how to protect the firm during lean times? Did Houston understand the immense changes taking place in locomotive technology with the introduction of Lima Locomotive's *Super-Power* designs in 1924, and the recent introduction of diesel-electric locomotives? Did Houston, the Fishers or the Baldwin Board understand the political positioning in Washington, D. C., and how an zealous political body had overregulated the railroads, sometimes to the sole benefit of the career of an elected officials, such as Congressman William P. Hepburn*, and his Hepburn Act of 1906.

Baldwin's locomotive sales were dropping off rapidly and as many of the Philadelphia area corporate boards had done after WW I, Baldwin Board members paid themselves huge dividends, depleting financial reserves and otherwise avoiding diversification investments, which had become critical to the survival of many firms.

Orders were in a near constant state of decline dropping from 1,696 locomotives in 1923 to a disastrous 87 locomotives in 1931. Baldwin needed an average of 600 locomotive orders annually to break even. Thus Houston entered into a plan to dramatically diversify and utilize the vast plant and machinery to attempt to maintain some level of non-railroad production.

Southwark Foundry and Machine Company

Alba Johnson and Samuel Vauclain by private sale purchased Southwark Foundry and Machine Company circa 1908 but maintained an arms-length management approach, allowing the managers great latitude in the daily operation. Then on May 11, 1916, Johnson made a press release that he and Vauclain had sold Southwark to The Baldwin Locomotive Works, but that it would continue its independent management. It was held away from the public eye by Baldwin until 1929 when, under Houston, it was brought

* Congressman William Peters Hepburn (Iowa) was quite actively engaged in railroad regulation and was for many years chairman of the Committee on Interstate and Foreign Commerce. He drafted the disastrously meddlesome and adversely controlling Hepburn Act of 1906, which greatly strengthened the rate setting and regulating authority of Interstate Commerce Commission over all railroad price making. It was a significant problem for shippers, passengers and railroads alike until the I.C.C. was abolished in 1981. It was often used as an anti-competitive tool to discourage railroad use, especially after the end of WW II when the Interstate Highway system was being constructed and federally subsidized modes such as airlines, highways, pipelines, and waterways were being built. Hepburn was also joint author of the Pure Food and Drugs Act (1906). He died in 1916.

fully into the Baldwin fold. The firm made castings, stationary steam engines, industrial presses, machine tools and a variety of forgings and enjoyed tremendous business with the Philadelphia area defense industry during WWI. It was the first non-railroad holding to come fully into Baldwin portfolio, and was the core entity to carry Baldwin through the depression and growth years of WW II. It was the core of diversification, taking Baldwin from being a locomotive builder to that of an industrial machinery and heavy equipment manufacturer.

Samuel Vaughan Merrick, founder of Southwark, left school in 1816, and went to Philadelphia, where he entered the countinghouse of his uncle. He subsequently studied engineering, and about 1835 established the Southwark iron-foundry, which became the finest work of the kind in this country. Among important constructions he built the iron lighthouses that were erected along the Florida reefs, some of them the largest in the world.

By the late 1880's Southwark Foundry and Machine Company was a noted world manufacturer. They operated a foundry that was held in high regard for the quality of workmanship.

When they were moved out to Eddystone,

during 1931, from their Philadelphia site, the manufacturing filled a portion of the old Remington Rifle/boiler shop, built in 1915.

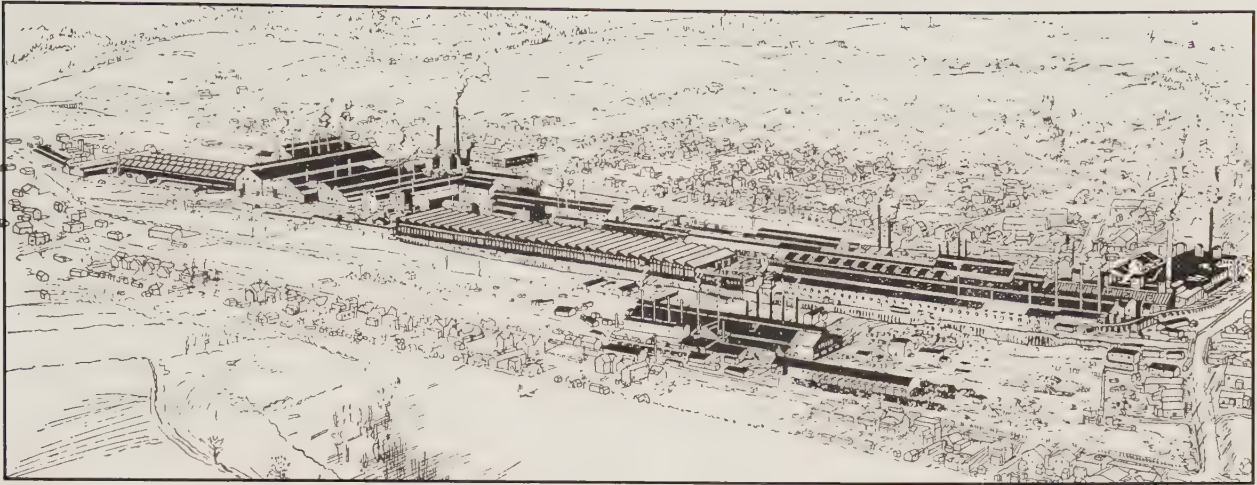
Baldwin-Southwark Corporation

As the Fishers continued to diversify Baldwin from locomotive manufacturing into that of a heavy equipment manufacturer they set up a subsidiary to handle the two major acquisitions; Southwark Foundry and Machine and I. P. Morris & De LaVergne Inc., into a wholly owned subsidiary, Baldwin-Southwark Corporation in 1931. That way heavy presses and diesel engine production was brought into a separate entity, away from locomotive production. At the same time Baldwin set up the De LaVergne Engine Company to handle the sales activity for all diesel engines. All Southwark presses carried product identification of "Southwark" and "Baldwin-Southwark." The diesel engine product line carried builders plates stating, "I. P. Morris & De LaVergne Inc." for its production in the 1930s. By 1940 the builders plate had been changed to read "De LaVergne Engine Company." After 1940 a Baldwin logo was attached to railroad diesel

Baldwin Locomotive Orders 1929 - 1938 During Fisher Control



This chart shows locomotive orders during the years of Fisher Brothers control. Newly installed Baldwin President, George Houston had his hands full trying to keep Baldwin afloat during the 1930's and sought diversification into non-railroad manufacturing, spending much Fisher money to buy other manufacturers and move their machinery and product lines to Eddystone. The greatly diversified Baldwin Locomotive Works never turned a profit under their control and entered receivership in February 1935. Houston never ventured into the lucrative area of diesel-electric locomotive manufacturing, perhaps to help protect the Fisher's position with General Motors?



The plant of Standard Steel Works at Burnham, Pennsylvania, circa 1939. It had been a holding of Baldwin since 1875, and produced steel and iron castings. Its original product line was freight and passenger car wheels and locomotive tires. Later it expanded into a diverse line of non-railroad products, and supplied many Baldwin subsidiary companies.
-- From a Baldwin Ad

engines, and they continued to carry the name De LaVergne.

The De LaVergne engines with the exception of the model VL, LV and VO were designed for stationary power generation, water and oil pipeline pumping, for driving ammonia compressors for ice making and refrigeration or for ship propulsion and auxiliary power requirements. Models VL, LV, and VO were designed for powering locomotives.

Standard Steel Works Company

The Standard Steel Works Company was situated at Burnham, about three miles from Lewistown, in Mifflin County, Pennsylvania. This site was nearly 100 miles west off Eddystone. The locality had long identified with the iron and steel industry.

There are 15 miles of track in and around the plant, owned by the Company, on which are operated nine steam locomotives, two electric locomotives, nine locomotive cranes, one self-propelled hoisting engine and 81 cars.

The entire plant is thoroughly modern in every particular with every labor-saving device incorporated. It represents the progress of

the iron and steel industry which has been continuous from the little forge of 1795, operated by water power and distributing its products by wagon, river and canal, to the extensively developed plant of 1924 with its diverse industries, capable of producing 200,000 tons of steel yearly and employing 5,000 men.

William Cramp and Sons Ship and Engine Building Company

Portions of this firm came into control of Baldwin in 1931, five years after it had ended shipbuilding operations in the Kensington district of Philadelphia. It brought to Baldwin the vital diesel and turbine product lines that kept Baldwin afloat when there were few steam locomotives to be built. The I. P. Morris Division of Cramp originally built the rugged De LaVergne diesel engine used in ships, industrial, stationary generators and future railroad applications as well as a line of steam turbines.

William Cramp started his shipbuilding venture on the banks of the Delaware in 1830, it was one of thirteen private shipbuilding establishments operating along the Philadelphia waterfront. Cramp was one of the few American ship-

builders to survive the transition from a craft mode of production which focused around wooden sailing vessels to an industry centered around steam engines and iron and steel construction. Cramp evolved into a multi-divisional corporation with vast productive capacity. In 1919, the company became part of the Harriman owned, American Ship and Commerce Company. A series of reversals led to the decision to separate the shipbuilding division from the other profitable machinery divisions. Shipbuilding was discontinued on April 16, 1927. Although the Cramp yards reopened in 1941-46, work did not continue after massive wartime contracts were completed. The Cramp firm had a powerful impact on its home neighborhood of Kensington.

By the late 1840's, William Cramp relocated to a site on Palmer Street. This was the era of the great oceangoing clipper ships. The clipper ships were fast wooden cargo vessels which formed the backbone of the American merchant marine. From 1849-53, Cramp built six clippers for the California trade. One of them, the Bridgewater, was a ship weighing around 1,500 tons. In addition to these major assignments, Cramp built smaller brigs and schooners.

William Cramp was the father of nine children in which all of the males were trained in his trade. His son's carried on the business while he remained as the foreman. In 1860, William, Charles, and William M. Cramp after going separate ways came together under the name of "William Cramp and Sons, Shipbuilders."

It was the sons, particularly Charles, who led the firm into steam and iron. Throughout his life, William remained devoted to wooden shipbuilding and the craft skills it entailed. William carved his own models, selected the trees to be cut, and choose which parts were to be used for making plankings, masts, and hulls. Cramp's entree into steam navigation developed in a similarly fashion. In 1847, when William was arranging commissions for large sailing ships, there were almost eighty small steam vessels operating on the Delaware and Schuylkill rivers. Although steam powered vessels had been built with some fre-

quency along the Delaware since John Fitch's practical application of the steam engine in 1786. These crafts were generally driven by walking beams connected to paddle wheels.

During the late 1860's, Charles Cramp continued to familiarize himself with the techniques employed in Philadelphia engine shops. His work led to a collaboration on an iron coastal steamer, the Clyde. The Clyde not only was Cramps' first ocean going steamer, but it was the first ocean steamer in the country equipped with a compound engine. The advantage of the compound engine was that it squeezed more work out of steam by running it through a series of cylinders. Since compound engines required less coal, they freed cargo space, an important breakthrough for American shippers. From then on, the Cramps resolved to concentrate solely on the production of iron ships. The shipyards joined together with the ASC, American Steamship Company, which resulted the business in dramatic growth for the Company. The Cramps purchased an area of land at Richmond and Norris streets where they proceeded to construct a new plant. They converted the old yard to a basin dry-dock and marine railway to use mainly for repairs and alterations. The firm incorporated as the William Cramp and Sons Ship and Engine Building Company.

In 1891, Cramp purchased the I. P. Morris Company, which was a noted marine steam engine manufacturer. Morris also pioneered the production of hydraulic machine-tools for plate bending and hydraulic riveting and began diversification by supplying similar tools to other industries. Cramp also purchased the small shipbuilder Charles Hillman Company. Coming into the Cramp portfolio that same year was the B. H. Cramp Manganese Bronze Works, a foundry that produced the new type of bronze screw propeller, which proved itself as highly successful. That same year the Cramp firm upgraded its machine shop and power plant.

Charles Cramp remained the major shareholder in the company and a vital force in its operation until

his death in 1913. Two years later, the company passed out of the hands of the Cramp family and was bought by W. A. Harriman's American Ship and Commerce Corporation in 1915. The firm was reorganized and incorporated as the Kensington Shipbuilding Corporation.

With the development of torpedo boats and submarines, Cramp began to produce destroyers designed to be long, light, and fast. From 1910-15, the Cramp yards employed around 5,000 workers and by 1917, the workforce averaged at least 10,000. The United States had its first turbine driven commercial ship in 1906, and its first turbine powered battleship by 1908. In 1920, the government ordered a decline which forced Cramp to abandon his shipbuilding activities in 1927.

During the first World War, the Cramp Shipyard was at its climax of prosperity and productivity. It continually expanded not only in location, but more importantly in the amount of workforce. The Cramp Shipyard was the leading employer in Philadelphia during that time, and the economy of the city was booming from this impressively lucrative corporation. During the first World War, the company built forty-six torpedo boat destroyers, three transports, two freighters, and four tankers. One estimate claims that the Cramp Shipyards produced one-fourth of the naval tonnage used in the first World War.

After World War I, the depression hit Philadelphia's economy hard. The Cramp Shipyards were no exception. The termination of the war left no demand for naval ships. The United States government cut their defense spending drastically. The U.S. also had to comply with an international naval disarmament agreement. All that along with a downturn in world trade lead to the shipyards closing in 1927.

DeLaVergne Refrigeration Machine Company

Financial control of the De LaVergne Machine Company was held by German subjects. In

April 1917, the year of the entrance of the United States into World War I. The property was seized by the Alien Property Custodian of the United States. In 1918 the business was purchased by the William Cramp and Sons Ship and Engine Building Company of Philadelphia.

For the duration of World War I, Cramp operated the De LaVergne plant in New York under U.S. Navy Department direction. The manufacture of commercial refrigeration equipment and oil engines was curtailed and production was shifted to support the war effort with items such as steam turbines for destroyer and cruiser propulsion, ship steering gear, mine laying apparatus and the manufacture of 200 Laurence nine-cylinder radial aircraft engines for the government. Subsequently the Wright brothers adopted the Laurence engine design as their standard for the airplanes their firm built. The engines then became known as Wright Whirlwind motors.

It is interesting to observe that at the time Cramp acquired De LaVergne, Cramp in its own right was a marine Diesel engine builder, manufacturing under license from Burmeister and Wain of Copenhagen, Denmark. B&W is a noted builder of very large Diesel engines for ship propulsion.

The Cramp-built engines were designated in the trade as "Cramp's B&W Marine Diesel Engines."

Cramp-Morris Industries

Prior to the discontinuance of shipbuilding activities of the William Cramp and Sons Ship and Engine Building Company in 1927, their De LaVergne Machine Company was separated from the shipbuilding division and reorganized into a part of Cramp-Morris Industries, Inc., a holding company formed to operate the Cramp company's subsidiaries while it retired from shipbuilding activity.

From its founding in 1880 the De LaVergne manufacturing plant had been located in New

York City. In the fall of 1928 the De LaVergne Machine Company operations were moved to the Cramp facilities at Philadelphia, in order to effect a better division of work between their shops and those of I. P. Morris Corporation, a heavy machinery manufacturer and one of the major companies in the Cramp-Morris group. At this time De LaVergne was merged with I. P. Morris and the new company that was formed was called I. P. Morris and DeLaVergne, Inc.

The De LaVergne Diesel engine design and construction activity continued until 1931 at the Cramp shipyard shops in Philadelphia at the massive plant at Richmond and Norris Streets. Certain of the established line of model V engines, including the VA and VG, were uprated in horsepower and maximum speed and new engines were developed. With its acquisition by Baldwin in 1931, the tooling and equipment was moved down to the Eddystone and occupied space in the first erecting shop building near Chester Pike. Baldwin also changed the corporate identity for the De LaVergne and Southwark to Baldwin-Southwark Corporation in 1931.

Pelton Water Wheel Company

Of all the unrelated subsidiaries to come into the Baldwin fold under the reign of the Fisher's was the Pelton Water Wheel Company of San Francisco, California. In the immediate years following the end of WW I Pelton had itself come into the ownership and control of Harriman's Cramp Ship Yard at Kensington, on the north side of Philadelphia.

When Cramp fell on hard financial times its dependable and profitable subsidiaries were separated into a new division, Cramp-Morris Industries and went on the sale block to help retire the massive debt of Cramp. Pelton with the Cramp-Morris and DeLa Vergne holdings came as a single holding to

Baldwin. Pelton was noted for its success in designing and building water turbines, everything in fact, from very small water wheels for residential use to massive turbine plants that rivaled the power output of the largest Corliss steam engine.

The Pelton wheel used the momentum of a water jet impinging on buckets attached to the periphery of a wheel to produce power. It was a development of the primitive, so-called "hurdy gurdy" wheel used in the California gold fields in the 19th century.

In 1849, several young men from Vermilion, Ohio, made the journey to California in search of gold, 17 year-old Lester A. Pelton, among them. The initial quest was not successful. He was described as a handyman, carpenter and millwright. Pelton built a small shed in the backyard of his landlady's house in the gold mining town of Camptonville, California, and spent his evenings tinkering with small experimental wheels. He hoped to harness water from the mountain streams as a source of power to run the machinery of the gold mining companies. He reportedly devised and built 40 models, including one that powered the landlady's sewing machine.

Pelton's water wheel was a match for Cramp's I. P. Morris, which was manufacturing large steam turbines for the shipbuilding industry. A large manufacturing plant was maintained at San Francisco, California, with capabilities that rivaled those of the Southwark facility in Eddystone. It continued operation through the end of WW II.

The Pelton holding was maintained as a subsidiary of the Baldwin-Southwark Corporation and went on to design and manufacture power interruption valves, speciality check valves for water and petroleum and an assortment of support components. Partial manufacturing was moved to Eddystone and manufacturing carried out in the Baldwin-Southwark plant.

A test lab was built across Little Crum Creek east of the Chester Pike where prototype testing of hydraulic turbine designs was undertaken.

Whitcomb Locomotive Works

The first Whitcomb electric trolley locomotive was produced in 1921. In 1929 Whitcomb designed and built the largest gasoline-electric locomotive that had been offered to American railroads. That same year 1929 the company became bankrupt Baldwin Locomotive purchased a 49 per cent interest in the Company with an announcement of April 2, 1929.

From 1931 until 1940 the company was operated as the Whitcomb Locomotive Works, a subsidiary of The Baldwin Locomotive Works. The firm continued to manufacture a line of coal and aggregate conveyors, road maintenance machinery and haulage engines, with a new emphasis on the diesel-electric locomotive.

Their diesel-electric locomotives utilized Westinghouse electrical apparatus, but a multiple of diesel engine suppliers including De La Vergne, Caterpillar, Hercules, Waukesha, Cummins and Superior engines.

During 1940, Baldwin completely took over the

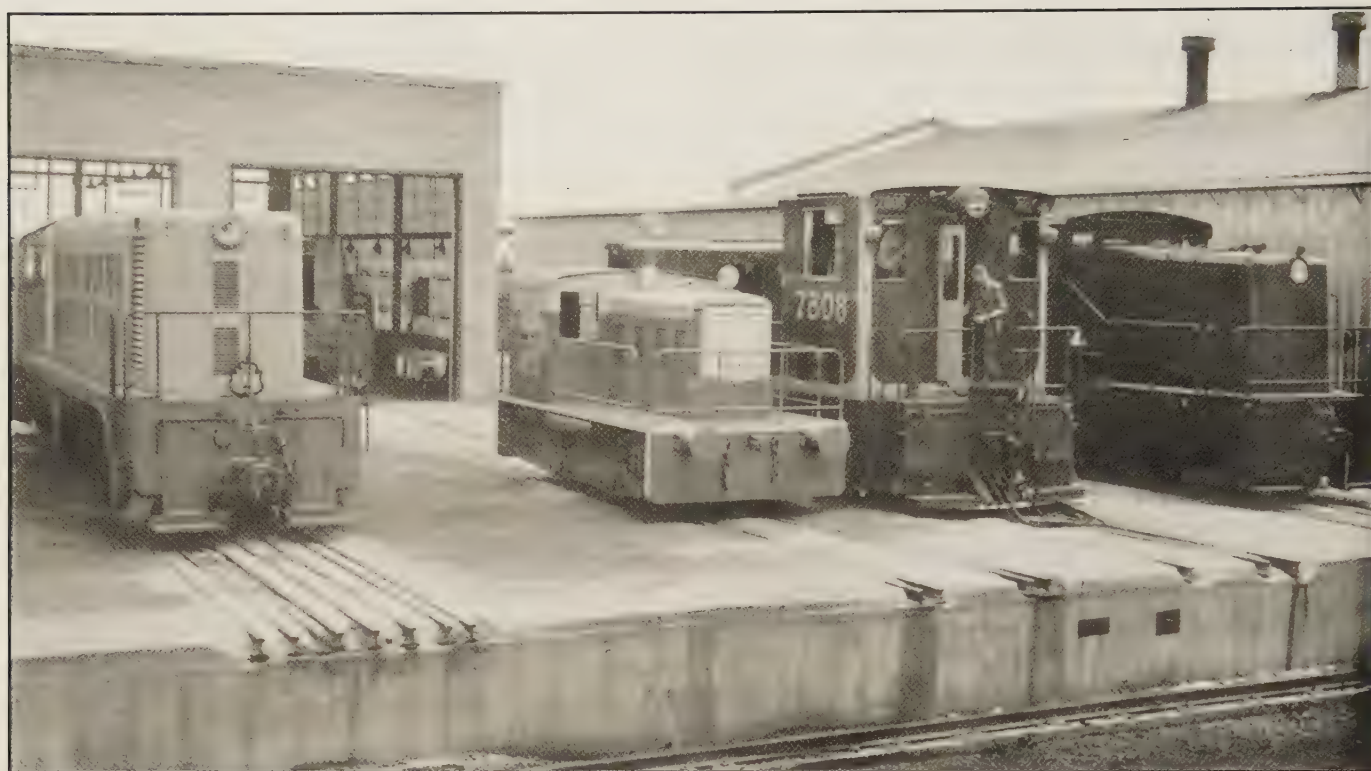
company and after that time it was operated as a division of Baldwin known as The Whitcomb Locomotive Company.

In February of 1952 locomotive production was shifted from Rochelle, Illinois to Baldwin's Eddystone, Pennsylvania Works. Industrial locomotives continued to be built under the Whitcomb name at Eddystone through the end of December 1952, when the name was dropped. Any Whitcomb locomotives built after that time carried the B-L-H identification.

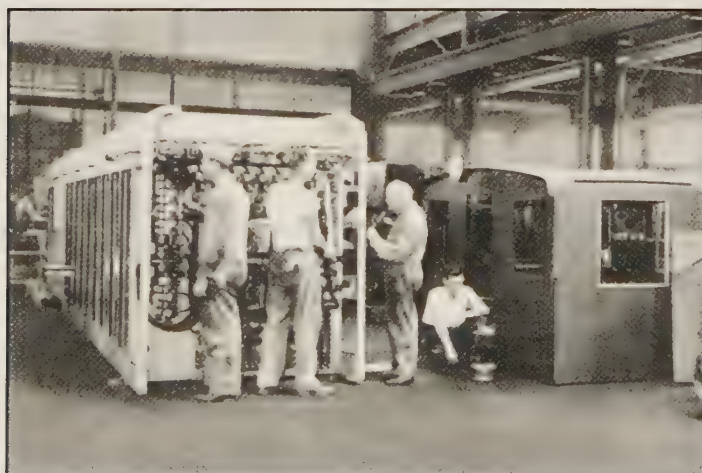
The last Whitcomb locomotive manufactured at Rochelle was shipped on January 4, 1952, construction number 61189. It was a 25-ton Diesel-electric locomotive delivered to the Central Procurement Agency of the Transportation Corps. This locomotive was lettered and numbered USN No. 65-00330. Production of the Whitcomb locomotive line came to an end in March, 1956. Whitcomb built an estimated 5,000 locomotives. The company also built industrial railway cars and automobiles.



Built at Rochelle, Illinois, the USATC Whitcomb built 65 ton center-cab was popular. These were built starting in 1942. It followed the lines of patents issued to Conrad C. C. Burkhardt of Baldwin Locomotive Works in 1935. Many were built for use by the United States Army Transportation Corps in North Africa, Italy and Europe during WW II. Significant numbers were returned back to the United States and sold as Army surplus at the end of WW II. The locomotive pictured above had body styling for use in the European Theater of Operations during WW II. The units sent to North Africa were distinctively different.

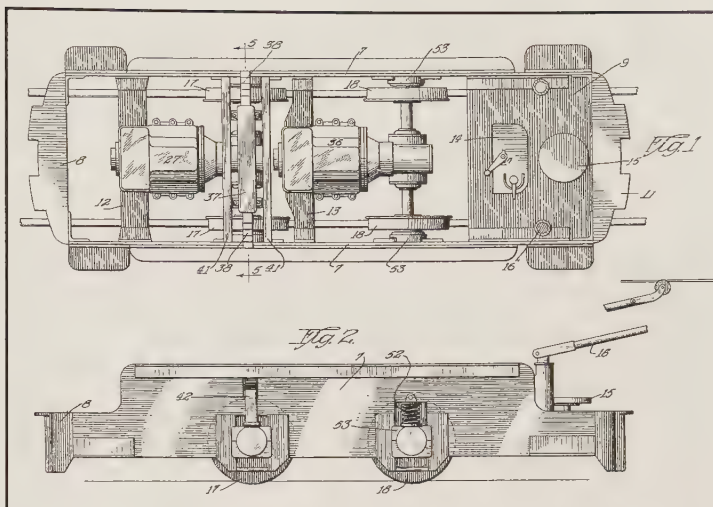


Whitcomb Locomotive facilities at Rochelle, Illinois in 1949. They built all types of diesel locomotives ranging in size from 3 to 104 tons for track gauges from 18" to 66". They were found in all the corners of the world hauling materials on railroads and construction projects, in steel mills, mines, refineries, logging camps and docks. (TOP) Finishing area. (RIGHT) Assembly area. Three years later these facilities were vacated and final production was moved to Baldwin's plant at Eddystone, Pennsylvania.



(LEFT) Wiring an electrical cabinet at Whitcomb. Westinhouse supplied the electrical apparatus. A variety of diesels were manufactured here since this was the industrial locomotive side of The Baldwin Locomotive Works.

The George D. Whitcomb Company competed directly against Baldwin with its line of gas-mechanical locomotives and electric mine locomotives. Illustrated here is their patent for an electric mine locomotive. The application was filed June 13, 1924, by William Whitcomb and William Eckert. This unit was much simpler to manufacture than Baldwin's bar frame unit. -- *United States Patent Office Patent 1,649,429.*



Whitcomb's Acquisition of The Milwaukee Locomotive Manufacturing Company

On July 19, 1932, Whitcomb Locomotive Company acquired the Milwaukee Locomotive Manufacturing Company. The Milwaukee Locomotive Manufacturing Company of Milwaukee, Wisconsin, was organized under the laws of Wisconsin in October of 1907. They competed directly against Whitcomb for a number of years producing small industrial mule type internal combustion locomotive. They entered upon the industrial locomotive manufacturing business in 1909.

Milwaukee locomotives production grew from 2 ton locomotives in the early days to 20 tons in the later years. They only produced 4 wheel locomotives equipped with the gasoline engines and mechanical transmissions, in gauges ranging from 18 inch to 56.5 inches.

Originally Milwaukee's manufacturing operations were conducted separately, but shortly after, and certainly by 1910, their manufacturing was carried on as a department of the National Brake & Electric Company of Milwaukee, which in turn had been a wholly owned subsidiary of the Westinghouse Air Brake Company circa 1910.

On July 19, 1932, Whitcomb Locomotive Company acquired the Milwaukee Locomo-

tive Manufacturing Company from Westinghouse Air Brake Company, in an arrangement whereby Westinghouse became a minority stockholder in Whitcomb Locomotive Company. This acquisition included the business, its inventory and the good will of the company. The inventory was transferred to the Rochelle plant of Whitcomb and included 30 locomotives ranging in size from 4 to 16 tons, a large stock of repair parts, records, patterns and necessary machine tooling. This was done to insure present and prospective owners of Milwaukee locomotives they would have an uninterrupted, efficient and permanent source of parts and service. Whitcomb also received four completed locomotives that were stored and available for immediate sale on the Pacific Coast.

Milwaukee continued to operate as a subsidiary of Whitcomb/Baldwin until 1935 when its corporate charter was dissolved by Whitcomb and remaining products were sold directly under the Whitcomb name.

General Steel Castings Corporation

Baldwin had its Standard Steel plant out at Burnham, Pennsylvania, which was about 125 miles to the west, but did not concentrate on steel castings for locomotives. It relied on both ASF and American Locomotive for any local needs.

As Baldwin, American Locomotive and

American Steel discussed the changing needs for heavy steel castings, the market slipped into a deepening recession as 1928 dawned.

The Pullman Car & Manufacturing Company, owned a significant and secured interest in Commonwealth Steel Castings. To save the bankrupt foundry from liquidation, its assets were purchased by The Baldwin Locomotive Works, American Locomotive Company and American Steel Foundries. Pullman, through its secured interest was offered a partner position and thus included in plans to form General Steel Casting Corporation. Each of the owners initially held about a 25% ownership interest. It was described as a mutual risk corporation.

The General Steel Castings Corporation, was incorporated in the State of Delaware in 1929. Almost immediately they began a consolidation of two existing plants in Chester with a new plant to be built just up the river at Eddystone in 1931. It was to feed Baldwin and American Locomotive with integral cast steel locomotive beds and tender frames, and car builders and railroads in the eastern United States with car castings. Non-railroad castings were also poured at the plant.

American Locomotive's steel castings plant in nearby Chester, acquired in July 1917, from the former Penn-Seaboard Steel Company's Seaboard Steel Castings plant was sold to GSC as part of the plan for the new plant. The old plant at Front and Jeffrey Streets had a capacity of about 18,000 tons of steel castings annually. All heavy work and personnel were moved there.

Other Lesser Holdings

Baldwin had acquired a significant interest in the Flannery Bolt Company of Pittsburgh, Pennsylvania. The exact date of this acquisition

has not been determined. Indicators point toward the 1920s. They were a primary supplier of firebox and boiler stay bolts and associated hardware and testing equipment, supplying locomotive and boiler manufacturers plus the railroads.

Other companies for which Baldwin held a direct but undetermined interest during the years between 1927 and 1939 included:

Cuba Locomotive Machine Works, a subsidiary of the Baldwin Locomotive Works, dissolved as of Sept. 6. 1929.

Caprotti Poppet Valve Gear.

Valve Pilot Corporation - boiler gauges and indicators, New York, New York.

Sunbeam Electric Manufacturing Company - turbo-generators and headlights, Evansville, Indiana.

Manning, Maxwell & Moore, Inc- Hancock boiler equipment and Ashcroft gauges and indicators.

Lewis Bolt & Nut Company - car bolts, Minneapolis, Minnesota.

Wilson Welder & Metals Company, Inc. - Arc Welding Machines and wire, North Bergen, New Jersey

Watson-Stillman Company - Hydraulic jacks and presses, Roselle, New Jersey.

Fairmont Railway Motors Inc. - Inspection and motor cars, Fairmont, Minnesota.

Templeton, Kenly & Company - Railway jacks, Chicago, Illinois.

Whiting Corporation - Shop cranes, hoists, transfer tables, drop pits - Harvey, Illinois.

Industrial Brownhoist - Locomotive cranes, coal and ore handling bridges, ship cranes, gantry cranes, wrecking derricks, bridge tramway cranes - Bay City, Michigan.

Baldwin was the export agent for all of the above companies, several of which had nothing to do with locomotive manufacturing.

Receivership and Reorganization

Empty coffers and a string of annual losses in the locomotive business caught up with The Baldwin Locomotive Works. The first indication of problems came to light in 1932 when the annual report mentioned losses in the locomotive division since 1929.

Orders remained in steep decline with the plant receiving a mere 87 orders in 1931. The Lehigh & New England placed orders for one 0-6-0, three 0-8-0s and two 2-10-0s. The Philadelphia & Reading took ten 2-10-2s, the only mallots produced during the year were five 2-8-8-2s for the Western Pacific and eight 4-6-4s for the Milwaukee Road. The Lehigh Valley purchased a single 4-8-4. A few industrial locomotives were ordered and export sales amounted to a total of seven locomotives, five being 2-10-2s for Russia. The electric locomotive production was for smaller mine mules and industrial units.

It hardly paid Baldwin to try and build any locomotives during 1932. The Imperial Government of Persia (Iran) purchased four 2-6-0 oil burners followed by the Lehigh Valley coming in with a follow-up order for nine more 4-8-4s. The Alaska Railroad purchased a single 4-8-2. All steam locomotives were delivered by the end of May. The balance of the year was spent building the carbodies for the first 32 Pennsylvania P-5 2-C-2 electrics. With the throws of the depression gripping everything, the bodies were taken to the Westinghouse Electric South Philadelphia plant and prepared for installation of the electrical apparatus. The balance of business was confined to a few electric mules, for total production of just 65 units in 1932.

Baldwin continued its production of P-5s for the Pennsylvania Railroad, with a scant three or four a month coming out the gates of Eddystone through April. Further production was put on

hold until 1934. A disastrous six steam locomotive orders were fielded all year, a single 2-6-0 for an oil company, the only articulated locomotive for the year, a 2-8-8-2 for Weyerhaeuser Timber and a 2-10-0 for the Durham & Southern Railroad. Three locomotives went to export, a pair of 2-8-2s and a single 2-6-0. There were a few electric mules.

The last eleven of the Pennsylvania Railroad P-5s were completed during March and April 1934. Steam production was shut down part of the year, but hope returned along with orders for ten articulated locomotives; one 2-6-6-2T for export, a 2-6-6-2 for Weyerhaeuser Timber and eight 2-6-6-4s; three for the Pittsburgh & West Virginia delivered in September 1934 and five for the Seaboard Air Line Railroad. The Northern Pacific received seven of an order for ten 4-8-4s. The balance were delivered in February 1935. Twelve locomotives were built for export and the experimental 0-4-0ST was built for Standard Steel Works. Production totaled just 73 units in 1934. Electric locomotive orders outstripped traditional steam locomotive orders for every year since 1931, and the drain of unused fixed assets (idle manufacturing equipment) took its toll.

On March 1, 1933, Baldwin went into default on real estate mortgage bonds issued in 1929, to originally provide short-term operating cash. A petition for a receiver in equity for the Baldwin Locomotive Works was sought by a small bondholder to force it to pay \$12,000,000 of three-year 5 1/2 per cent gold notes which matured on March 1. The petition was filed April 13 in Federal District Court by Bainbridge Colby, on behalf of Patrick J. McNaney of New York, who held \$19,000 of the notes.

Baldwin for their part answered the petition with the position that the bondholder had no

standing to sue. Baldwin asked for immediate dismissal of suit. After hearings on the matter the Court disagreed and allowed the petition to stand and for a Receiver to be appointed. The fate of Baldwin as the leader in American industrial giants was sealed.

While the problems of the bonds were sorted out, Livingston E. Jones, president of the First National Bank of Philadelphia, was elected a director of the Baldwin Locomotive Works to succeed Arthur W. Cutten.

In October 1934, Baldwin officials announced the corporation could not pay the interest on its bonds, sending shock waves through financial markets. The Securities and Exchange Commission had begun an investigation into misleading earnings statements as a result of numerous complaints.

On February 25, 1935, a federal declaration of bankruptcy was filed under provisions of the National Bankruptcy Act. The Eddystone complex was largely devoid of work, with just a skeleton work force making locomotive parts and miscellaneous industrial parts. Just two months later the SEC came out with a scathing report charging, "*the company's annual reports for the years prior to 1934 actually misled the investing public.*" Baldwin accountants were publishing a consolidated balance sheet that included not only wholly owned subsidiaries but also firms in which they had a partial ownership interest, including Midvale Steel, of whom they held a 60% interest. The SEC charged Baldwin was able to show larger quick assets (cash, accounts receivable, materials in process of manufacture) than it actually possessed.

Baldwin's president, George H. Houston responded to the SEC concerns by stating, "*The company has endeavored to present its financial position to its security holders and to the public in the clearest and simplest manner possible.*" He declared, Balance sheets for 1930 and 1931, "*disclosed all the information that any security holder could reasonably require.*"

The SEC confined itself to scolding. The

company had apparently violated no law, but it made national business news journals and suffered much public embarrassment.

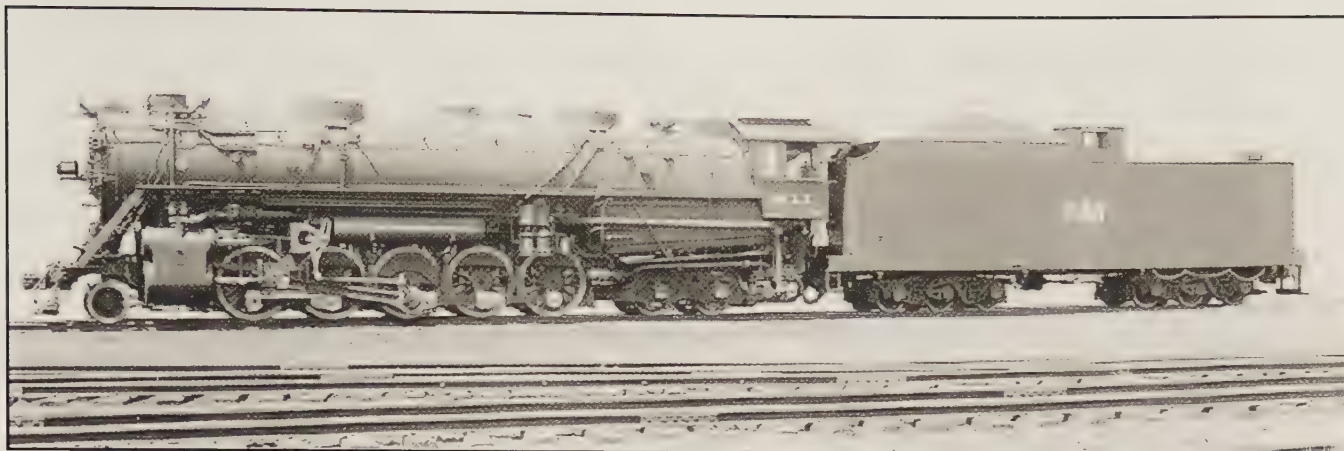
Baldwin officials openly complained during the peak of the Great Depression, "*Locomotive builders wish their products didn't last so long. Of steam locomotives in service [in 1935] almost two-thirds are twenty years old. Many carriers lack the money to buy up-to-date equipment.*"

"*But those old iron horses take a toll in higher operating costs. Modern engines burn less fuel, run faster, and pull heavier loads than those built a generation ago.*"

While a reorganization would soon be completed, the decline in the number of locomotives ordered from the company had wounded it severely, forcing drastic action. And exactly two months later, on April 25, it would become clear that Baldwin's leaders still did not fully believe in the concept of the diesel. On the evening of the 25th, a Baldwin Locomotive Works vice president, Robert S. Binkerd, spoke before the New York Railroad Club. His speech, entitled "*Muzzle Not the Ox that Treadeth Out the Corn,*" suggested that the future belonged to modern steam locomotives, not diesel-electrics. While the more perceptive listeners in the audience could not disagree more, Binkerd's presentation was illuminating. The higher-ups at Eddystone still had not gotten the picture.

Some of the directors of the Baldwin Locomotive Works began to see the handwriting on the wall, however. In 1939, they forced a change in management which brought about a new corporate outlook. Baldwin's new management team soon set out to embrace the diesel-electric locomotive. Yet the future was not assured, for Baldwin, a leader of steam builders for generations, lagged far behind General Motors, the auto maker which had entered the diesel locomotive market in force.

In February 1937, Federal Judge Oliver B. Dickinson, sitting on the bench of Federal District Court, Philadelphia, approved a reorganization



Bessemer & Lake Erie Number 614 c/n 61915 with 64 inch drivers. These 2-10-4s were built in June 1936, when there were virtually no locomotive orders at Baldwin. The order covered ten locomotives Numbered 611-620.

plan for Baldwin, hoping to release it from two years of protection under Section 77b of the Bankruptcy Act. More than 500 stockholders had objected to the plan, claiming it gave them a raw deal.

On September 23, 1938, the plan for reorganization was declared consummated and the company was successfully discharged from bankruptcy. The Fisher Brothers sold out their interest to The American Pulley Company of Philadelphia.

George Houston was released as President and replaced by Charles E. Brinley. He had previously been associated with Baldwin as a Director and member of the Executive Committee. Brinley was a graduate of Yale University, Class of 1900 in the Academic Course, and Class of 1901 in the Sheffield Scientific School. After completing his education, he spent a large part of his business life with The American Pulley Company at Philadelphia, serving as its President since 1919. His was a director of the United Gas Improvement Company, the Philadelphia Electric Company, Penn Mutual Life Insurance Company, and Liberty Mutual Insurance Company of Boston. He was also a Manager of the Western Savings Fund Society, a Trustee of Drexel Institute of Technology and a member of the American Society of Mechanical Engineers (ASME.)

Mr. Brinley, as chief of the Baldwin group, put in place a staff of men experienced in the design and manufacture of locomotives and other heavy machinery products.

William H. Harman was placed in the hot seat as Vice-President in Charge of Sales, he was noted as a manufacturer of long experience and wide acquaintance. His early training was with the R. D. Wood Company, manufacturers of various heavy machinery products. In 1915 Mr. Harmon became associated with the Southwark Foundry & Machine Company, well-known manufacturers of hydraulic presses and machine tools, serving as President from 1917 to 1929.

Baldwin fully acquired Southwark in 1930. At that time Harmon was moved over to Vice-President and General Manager of the Baldwin-Southwark Corporation, the Baldwin unit devoted to carrying on the Southwark business, and the manufacture of other heavy machinery including Diesel engines and hydraulic turbines.

Mr. Harman was President of the Diesel Engine Manufacturers Association, and a member of the American Society of Mechanical Engineers. His charge was to direct and coordinate the sales of the entire Baldwin group except The Midvale Company, for which Baldwin only held a 60% interest..

William H. Winterrowd, was hired as Vice-

President in Charge of Operations. He was a graduate of Purdue University, Class of 1907, receiving a degree as Bachelor of Science in Mechanical Engineering, receiving a Doctorate of Engineering in 1936. He was a veteran of long service with various American and Canadian railroads. His career started in 1907 as an apprentice with Lake Shore & Michigan Southern Railway, moving on to the Canadian Pacific Railway in 1912. He rose rapidly through the ranks, serving as Chief Mechanical Officer from 1918 to 1923. In 1923, Mr. Winterrowd joined the Lima Locomotive Works, working directly with William E. Woodard during the final development of the highly successful "Super-Power" locomotive design. He stepped into the position of Vice-President in 1927, just after Lima had undergone an expansion of the physical plant and was experiencing good growth. He remained at Lima into 1934, resigning to move onto another of the Coffin holdings, Franklin Railway Supply Company at Baltimore, Maryland, where he was Vice President. He was with Franklin until his resignation to come to the newly reorganized Baldwin Group.

Mr. Winterrowd was a member of the American Society of Mechanical Engineers, and of many different transportation and railway organizations. He was also a Director of the Purdue Research Foundation and Vice-President of Purdue Alumni Association. Purdue at the time was heavily involved in railway engineering with various labs and an extensive equipment collection.

Mr. Winterrowd was given complete charge of all manufacturing and production operations within the Baldwin group excepting Midvale Steel.

Otto V. Kruse, was appointed to General Sales Manager of Baldwin. He was a graduate of Cornell University, Class of 1909, with a degree in Civil Engineering. Up to 1917, he was with the Ontario Power Company of Niagara Falls in hydro-electric construction and operation. After a war activity in the manufacture of toxic gas, he became associated with the Lamer Engineering

Company and with the Wm. Cramp & Sons Ship & Engine Building Company, as a consulting engineer in the field of hydro-electric power development. He was subsequently appointed General Sales Manager of the miscellaneous machinery business of Cramps, including I. P. Morris hydraulic turbines and De La Vergne Diesel engines.

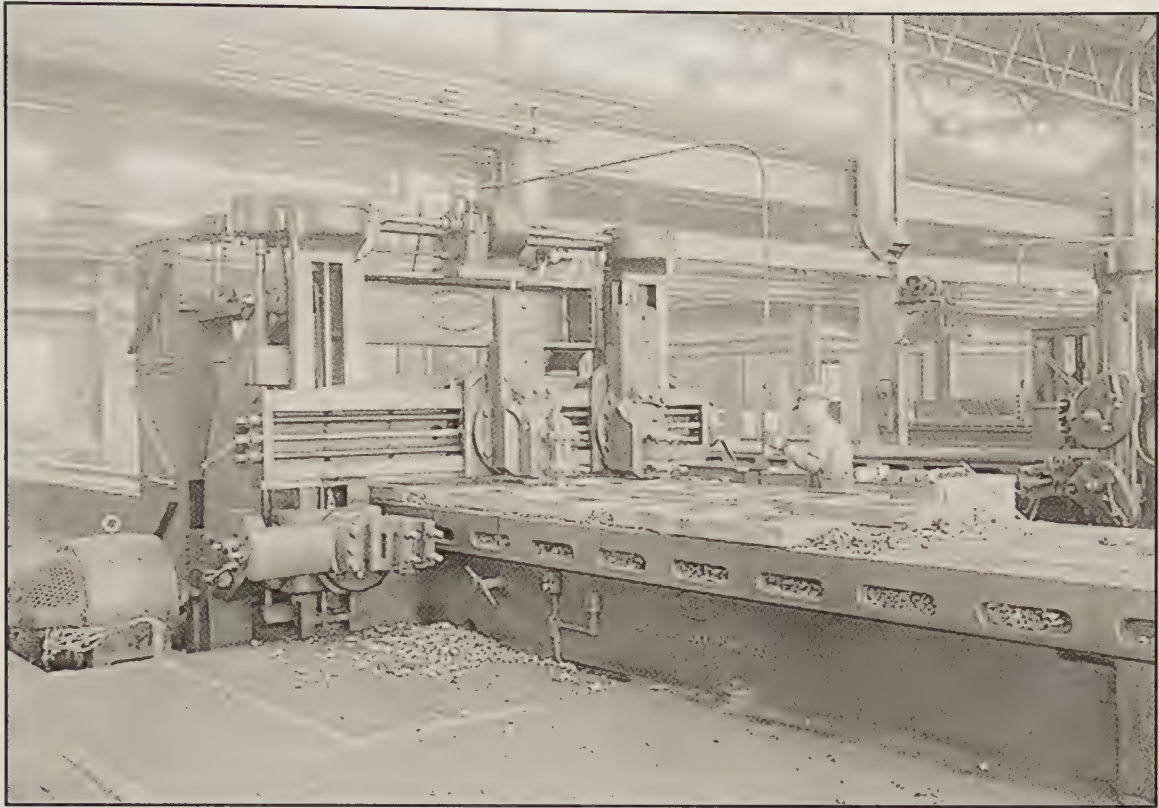
In 1931, when Baldwin acquired this business, Mr. Kruse became associated with William Harman as a general assistant, and later became General Sales Manager and finally Assistant General Manager of the Baldwin-Southwark Corporation.

Mr. Kruse was President of the American Hydraulic Corporation, a Director of the Cornell Alumni Corporation, a member of the American Society of Civil Engineers and of The Franklin Institute. He worked directly for Mr. Harman in the sales work of the Baldwin group.

To further the changes, a Sales Manager for Steam locomotive Division was split and the formation of Sales Manager, Diesel Locomotive Division.

The corporate structure of the Baldwin Locomotive Works was simplified in 1940 by merging many of the Baldwin Locomotive subsidiary companies into the parent company. In this process, Baldwin-Southwark Corporation and its subsidiary, the DeLaVergne Engine Company, became the Baldwin-Southwark Division of Baldwin

1935	STEAM	15
	ARTICULATED	1
	ELECTRIC	60
	GAS MECHANICAL	0
	DIESEL-ELECTRIC	0
	TOTAL	76
1936	STEAM	24
	ARTICULATED	15
	ELECTRIC	52
	GAS MECHANICAL	0
	DIESEL-ELECTRIC	4



A locomotive frame planer. This large machine planed a pair of frame castings to a smooth surface. The bed moved back and forth in a horizontal plane and the planing knives stayed stationary to removed the metal. This was part of the problem at Baldwin when it emerged from Receivership. It was still a heavy custom machinery builder in a new day when the buzz word had become production line and standardized equipment. -- *National Archives and Records Administration collection.*

	TOTAL	95
1937	STEAM	41
	ARTICULATED	1
	ELECTRIC	90
	GASMECHANICAL	0
	DIESEL-ELECTRIC	0
	TOTAL	132
1938	STEAM	75
	ARTICULATED	14
	ELECTRIC	12
	GASMECHANICAL	0
	DIESEL-ELECTRIC	0
	TOTAL	101
1939	STEAM	21

ARTICULATED	28
ELECTRIC	21
GASMECHANICAL	1
DIESEL-ELECTRIC	11
TOTAL	82

In late 1944, a further refining of the organization was undertaken Baldwin Southwark Division was dissolved, the name DeLaVergne was dropped and production of Diesel engines thereafter was carried on under the name of the Baldwin Locomotive Works until December 1950, and thereafter under the name of Baldwin-Lima-Hamilton Corp. "The only facilities in [the] enormous...Baldwin steam locomotive manufacturing complex that could be used to manufacture diesel locomotives [was] the tender shops, where



Driver center and tire mounted on a wheel lathe for turning to final diameter at Eddystone in March 1937. The massive size of steam locomotive components and the tooling required to machine them is evident in this photo. -- National Archives and Records Administration collection.

certain sheet metal forming equipment could be used to manufacture the diesel locomotive carboodies; the wheel and box shops which could mount wheels and gears on axles and assemble the trucks; and the erecting shop, which could be used to place the diesel engines in the locomotives. As was later proven when. . . Baldwin went out of the steam locomotive business, only approximately one quarter of this enormous investment in plant and equipment was required for the building of diesel locomotives,”

ELECTRIC ARC WELDING

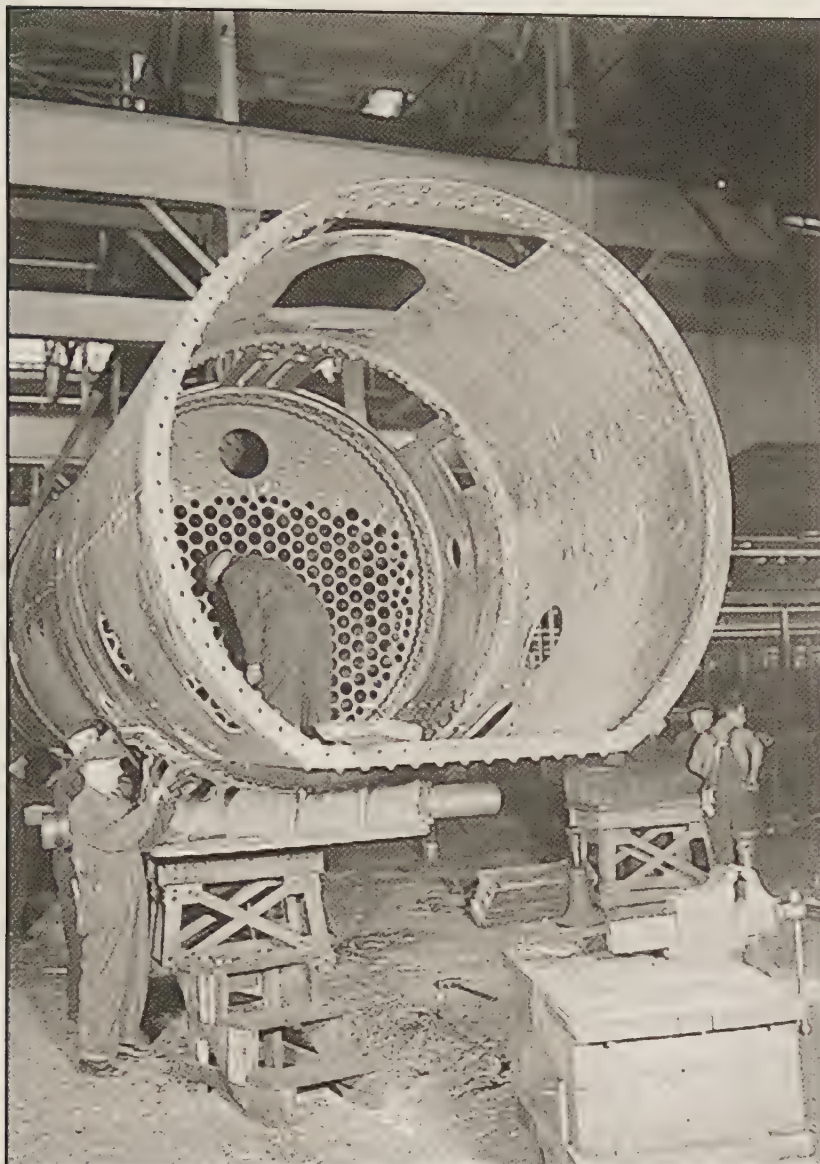
William Winterrowd and his staff faced sev-

eral internal challenges. They had plenty of unused manufacturing space under roof and some rather archaic manufacturing processes.

As war spread across Europe orders for military armaments once again began coming into Baldwin. The shop buildings and facilities east of Industrial Drive (Essington Avenue), once dedicated to locomotive frame and cylinder machining, were reopened for the manufacturing of tanks and large guns for the British.

The iron and brass foundry was beefed up as orders began coming in for ship propellers.

Baldwin also established one of the largest,



Smokebox of locomotive under construction at Eddystone in March 1937. The locomotive type is not identified, but the boiler size and smoke stack opening suggests it may be one of the Southern Pacific Cab-Forwards built that year. -- *National Archives and Records Administration collection.*

most modern and completely equipped weldment fabricating shops in the country.

Though the company was one of the earliest users of the welding processes, it was not until 1940 that a specialized shop was set up to handle the welding work load which had been developed through design changes in railway equipment, and to afford an additional manufacturing medium through which the company could establish product diversification and speed production.

The welding fabrication shop officially opened on September 1, 1940. The shop rapidly expanded its facilities, housed in a portion of the

tender shop and in 1944, at the peak of war time demands covered a working area of approximately 135,000 square feet. It was one of the busiest shops in the plant at the time. While welded construction was the specialty of this department, the diversity of products that could be fabricated was probably greater than in any other like area. It took away the need for castings, the time consuming production of castings, moldings, pouring, clean-up and machining that castings demanded prior to assembly.

The shop layout provided for straight line processing from indoor storage of plate to in-

spection and shipping of finished weldments with minimum handling of material. A spirit of optimism and pride was noted as characteristic of all employees of this shop and new production records were regularly established.

Foremost among the products of the Welding Shop were those associated with Baldwin-Westinghouse diesel locomotives.

The DeLaVergne diesel engine was wholly fabricated of rolled and cast sections welded together to produce a homogeneous unit.

An engine block primarily consisted of a frame, a bed plate, and generator bed plate. Other components and auxiliaries such as air intake header, exhaust manifold and chain guard housing.

Diesel locomotive parts were by 1944 completely manufactured in the Welding Shop. They included cab support, sand box, battery boxes, fuel oil tank, air starting tank, radiator expansion tank, fan bearing support stand, coupler supports, spring links, guide bars, and brake sheaves.

In addition to these are the truck equalizer beams and many other lesser components flame cut from rolled plate and machine finished in other departments.

The production of each of these several components was reduced to wholly repetitive fixture assembly set-ups followed by fully positioned welding. At this date welding was carried out by hand-held stick-electrodes (SMAW processes) which gave the best results if they could be welded in the flat, or nearly flat position. All parts were therefore characterized by uniform appearance and quality. Approximately half of the floor area of the shop was assigned to diesel engine production.

Control of quality from both a workmanship and material standpoint, was maintained through regular and orderly use of X-ray and magna-flux equipment to check the quality of the welded joints. X-ray equipment capable of penetrating through three inches of steel was in constant use for the purpose of searching out material defects, that could be cut out and repaired.

Plates used in the construction of the engine were first very carefully checked for possible flaws, such as laminations, by means of the magna-flux process. Any plates not giving positive indication of homogeneity were rejected.

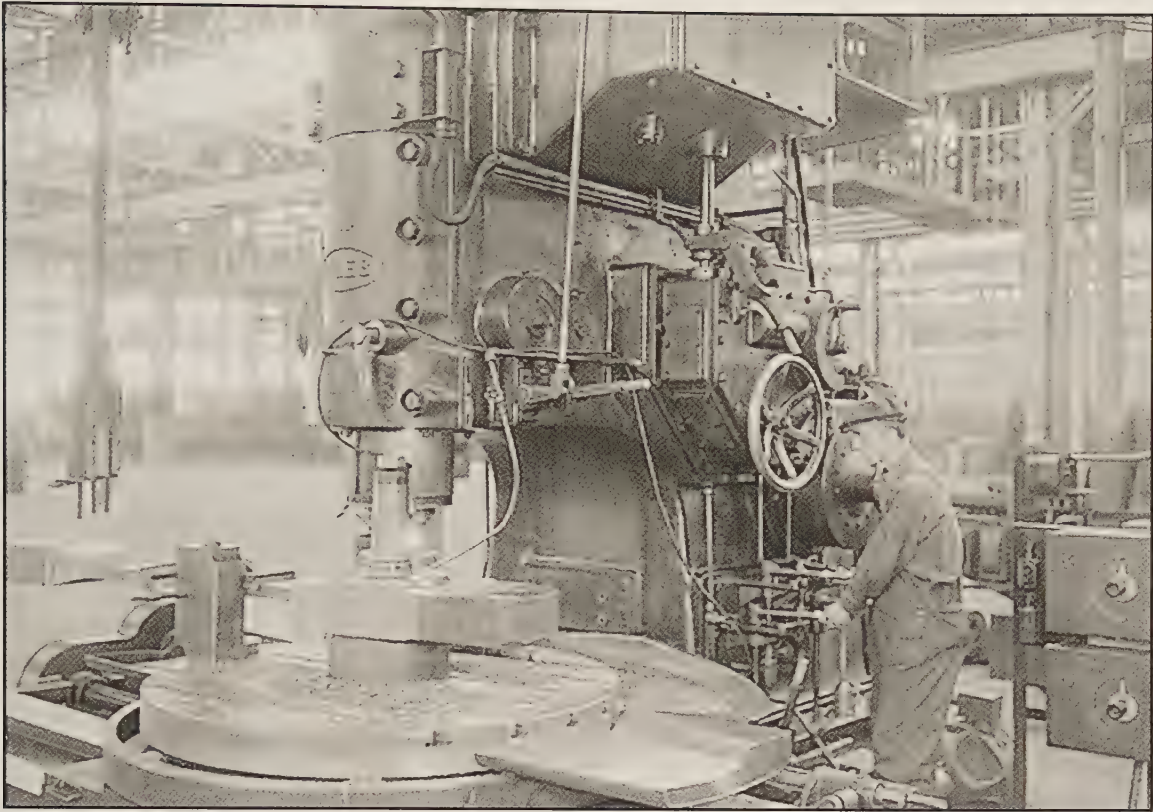
Two large stress relieving furnaces and shot blast equipment supplemented the direct production facilities for these diesel weldments. The furnaces were of the convection type and were fully machine controlled to produce predetermined heat treating cycles. This relieved stresses in the weld metal. All parts which were subsequently machined were stress-relieved prior to shipment from the Welding Shop.

Steam locomotive components and assemblies came high upon the list of products of the shop. January, 1944, saw the start of fabrication of locomotive tender tanks by the Welding Shop. This replaced the traditional drilling and riveting as the means of tender assembly. Wholly new methods were developed for the assembly and welding of tender tanks. It came about as a means of assisting in meeting the heavy production demands caused by war service production demands placed on Baldwin. Some facilities formerly used for the fabricating of armored military tank hulls were converted for use on this project.

Procedures similar to those in use in the shipbuilding industry since 1917 were developed wherein the completed structure was reduced to a number of subassemblies which could be fabricated with a minimum amount of handling and with the least man-hour effort.

All subsections were characterized by fixture assembly for repeatability from item to item and welding with maximum diameter stick electrodes base on the joint design, service conditions and plate thickness.

The completed sub-assembled sections were brought together and secured sufficiently to permit the lifting of the entire tank into a positioning device so that all joints remaining to be welded were done in the flat position. A large turntable (positioning device) rotated the tank about its longitudinal axis and all joints were thus brought



One of many vertical mills working on a locomotive drive rod.-- *National Archives and Records Administration collection.*

into the most favorable position for welding.

Much of the clamping of the assembly work was done with powerful portable magnets in lieu of the usual catch-bolts or clips and wedges, traditional with riveted assembly. Employees thought it unique that such a large assembly could be made without the use of a single hole or bolt, for temporary securing of parts. This was indicative of the radical and advanced production methods which have been developed and implemented

Another item manufactured on a production basis in the Welding Shop was the locomotive pilot. All welded assemblies of different styles were being produced. These assemblies had been reduced wholly to fixture set-ups and each one is therefore an exact dimensional duplication of all others of the same style. All they needed was a stock of cut steel to fit into the welding jig.

Baldwin looked into the welded fabrication of

steam locomotive cylinders. An all welded assembly of this item had much to recommend it over the conventional casting.

The Welding Shop had taken over the foremost part in the company's military tank construction program. It was the first shop to get into sustained quantity production in the manufacture of component parts for tanks and turned out thousands upon thousands of tank items to meet rigid production schedules.

Techniques of flame cutting and welding developed in this shop were subsequently followed by practically every other tank manufacturer in the country, including Lima Locomotive, American Locomotive, Chrysler and General Motors..

The first production-built all welded Army tank hull was made in the Baldwin Welding Shop from design modifications of riveted hull construction originally developed by the Shop Engineering personnel.

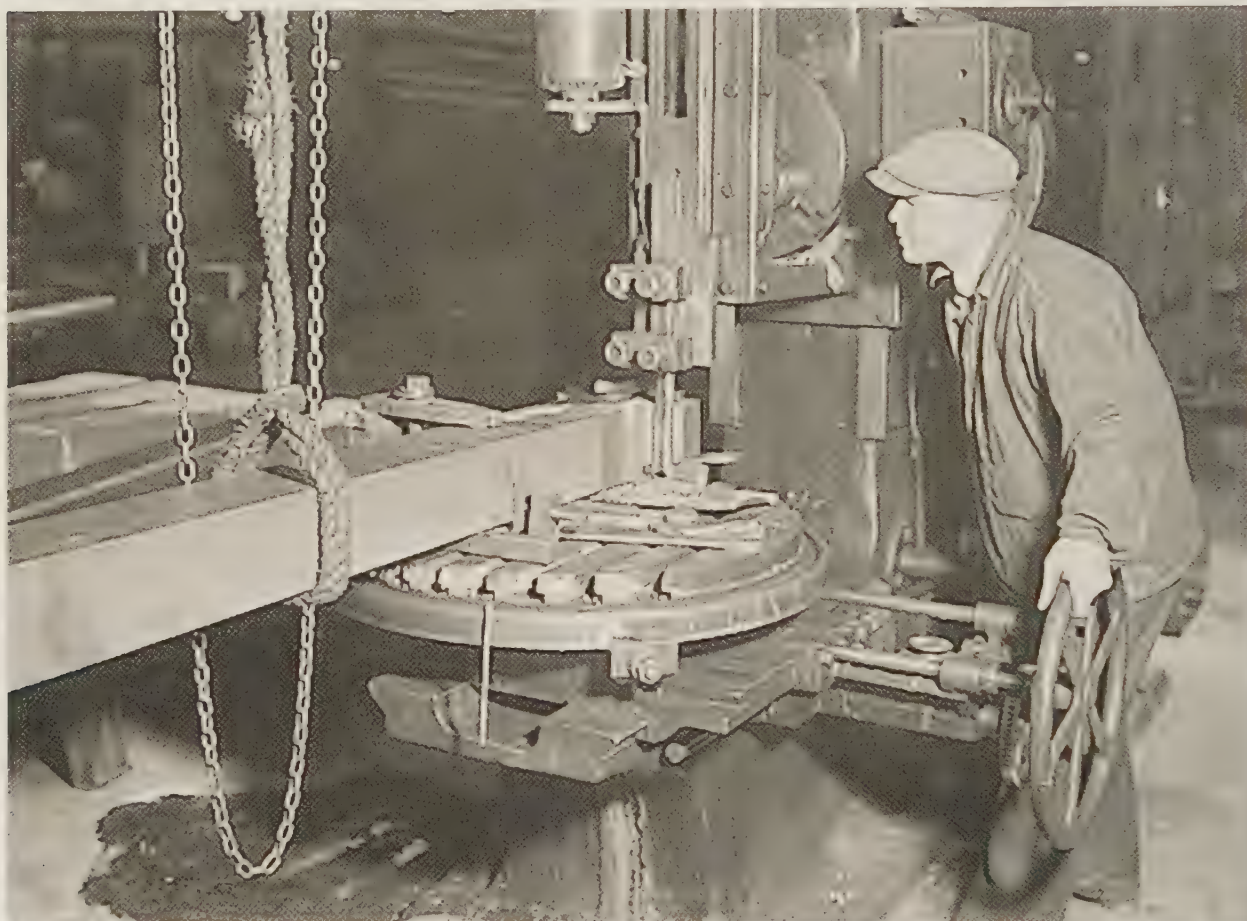
A considerable number of welded hulls were

produced and placed on the final assembly line before formal drawings or details of the construction were established. Many of those tanks were immediately forwarded to battle areas and gave good account of themselves, particularly in the North African campaign of 1942-43.

In 1939 a total of 107,000 pounds of electrode was used, which to that date represented the greatest quantity ever used on welded products of the company. In 1940 this figure rose to 154,900 pounds and in 1941 totaled 370,600

pounds. Increasing work loads brought this figure up to a whopping 1,165,550 pounds in 1942 and to 1,427,300 pounds in 1943. A record that of itself indicated the merit of the welding processes and the prospects of continued expansion of this field of fabrication in place of castings.

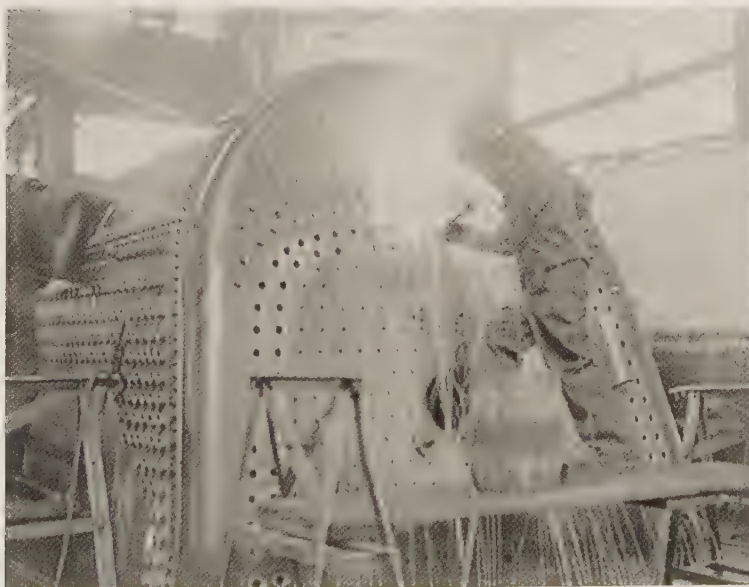
Baldwin produced but one two page article in 1941 focused more on how steam locomotive boiler codes and manufacturing should be permitted to replace riveted construction with welded construction.



A band saw cutting bar stock on a rotary table inside the Baldwin plant. -- *National Archives and Records Administration collection.*



Inside a locomotive firebox at the Baldwin plant. Laying on its side, boiler makers are tapping the holes in a syphon. This was a labor intensive operation, always carried out by hand. Note the second man in the background laying between the syphon tubes. In this era most boiler makers had a significant loss of hearing and were also known to be missing fingers from industrial accidents in this department. -- National Archives and Records Administration collection.



Cutting seats in staybolt holes on the backhead of a boiler in the boiler shop at Baldwin. This was a typical day for the man who is covered in protective clothing. -- National Archives and Records Administration collection.

1927 - A Turning Year

Baldwin's Enters the Super-Power Era

Baldwin was feeling the effects of a weak post-war economy as new locomotive orders slowed dramatically after 1923. A total of 457 steam locomotives were ordered in 1927 and that was not enough to cover operating costs at Edystone. Cash reserves continued to be drained.

The day of the conventional articulated locomotive promoted by Baldwin as the answer to higher power locomotives had faded into history with just a few exceptions. Some larger locomotives were being ordered to the new Super-power designs, which meant that railroads were looking to retire aged motive power and replace them as needed with fewer but higher horsepower locomotives. Larger boilers and newer high strength alloy steels lent to higher boiler pressures, which had traditionally been capped at about 250 p.s.i.

Vauclain held out hope his beloved articulated would be the answer as he moved forward with patents for the triple expansion articulated locomotives. In two patents, both granted on May 17, 1927, Vauclain put forth the concept of using steam three times before exhausting it. Patent

1,629,370 had the rear cylinder and the intermediate (middle) cylinder rigidly connected to the locomotive frame, an advance idea put forth some years later with the Duplex design. The front cylinder-set were on an independent articulated frame. It was the wrong direction to take steam technology, although Ralph Johnson, used the rigid frame idea for his duplex design as it was laid out on paper a few years later.

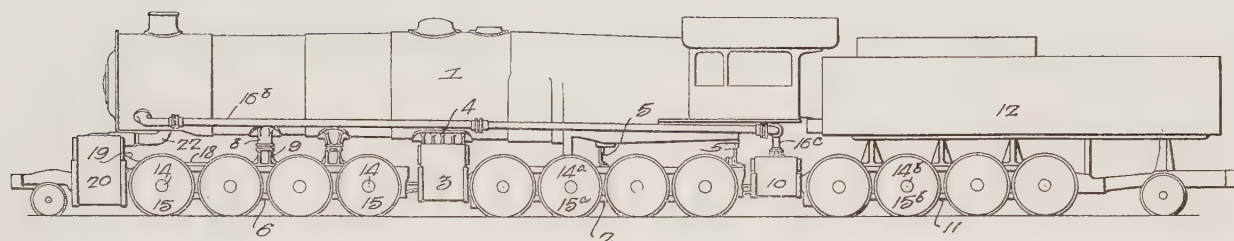
After the failure of the BLW 60000 and the overwhelming success of Lima's Super-Power design, Baldwin became a follower in the design and manufacturing of steam locomotive. After 1924 the single expansion articulated locomotive had evolved into a very capable machine, now that a boiler could be fabricated that would generate more steam than the engines could use. In theory a Super-Power articulated locomotive could lug a heavy train over mountain grades, and in flat terrain it could run at the same speed as a 2-8-2.

In 1928 the Southern Pacific, to gain an even more powerful and economical Cab-Forward locomotive, ordered a new design single expansion cab-forward articulated consolidation locomotive with a 4-8-8-2 wheel arrangement. The

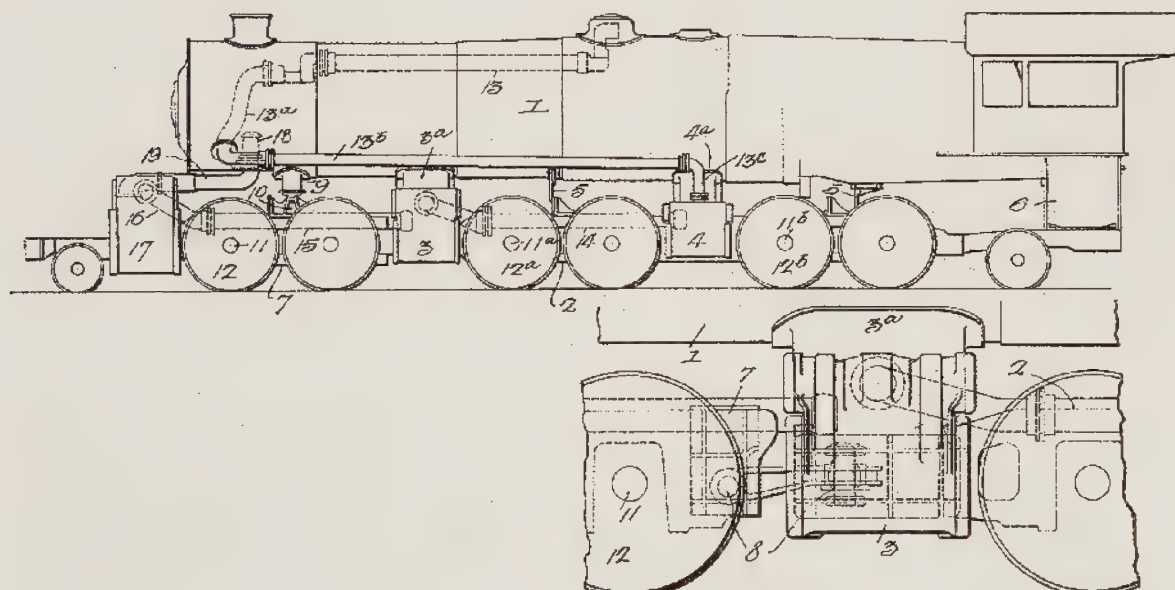


Baldwin builder's photo of Southern Pacific Cab-Forward AC-4 Number 4102 c/n 60622, The AC-4 was the first of a new design for the Cab-Forward and first of the 4-8-8-2 wheel arrangement. Note the Russian Iron jacket

Vauclain's Triple Expansion Patents



Patent 1,629,369 dated May 17, 1927, and applied for November 25, 1925, by Samuel Vauclain. The year Vauclain applied for this patent Baldwin fielded orders for just four articulated locomotives. The year the patent was granted Baldwin had one order on the books. The only difference evident between this patent and the triplex design was the triple use of steam.



Patent 1,629,370 also dated May 17, 1927, and applied for November 25, 1925, by Samuel Vauclain. After the failure of BLW Number 60000 Vauclain focused his attention on a 2-12-2 wheel arrangement locomotive, one with Caprotti poppet valves and the other a 2-4-4-4-2 triple expansion locomotive. This patent had the rear cylinder and the intermediate (middle) cylinder rigidly connected to the locomotive frame, an advance idea put forth some years later with the Duplex design. The market for triple expansion steam died after the November 1916, delivery of Virginian Number 700 the 2-8-8-8-4. Railroads wanted Super-Power designs and simplified maintenance.

first group SP Numbers 4100-4109, came from Baldwin between July and October 1928. They had an improved boiler, a four wheel truck to improve tracking and help to distribute boiler weight, four cylinders of 24 x 32, all being fed steam direct from the boiler and a higher boiler pressure of 235 psi. Their Tractive Effort was 116,900 pounds. These massive locomotives went from a 57 inch diameter driver to a 63 inch diameter. The blunted cab design changed somewhat with a rounding of the cab roof brow area, although the front was still flat. The first of the improved Cab-Forward's, Number 4100, was delivered in July 1928, c/n 60575 as their AC-4 Class.

The Souther Pacific was very satisfied with this improved Cab-Froward and placed a second order for 16 additional locomotives for delivery in June and August of 1929. This group, became AC-5 Numbers 4110-4125. The AC-4 and AC-5 locomotives were equipped with the latest appliances: the type E super heater with a front end throttle, Worthington BL feedwater heater with a 9000 gallon per hour capacity, mechanical lubricators, a combustion chamber, cast steel cylinder blocks, and lateral motion driving wheel boxes. These engines weighed 310 tons and developed 116,900 lbs. tractive power. They were fitted with a cast water bottom cylin-

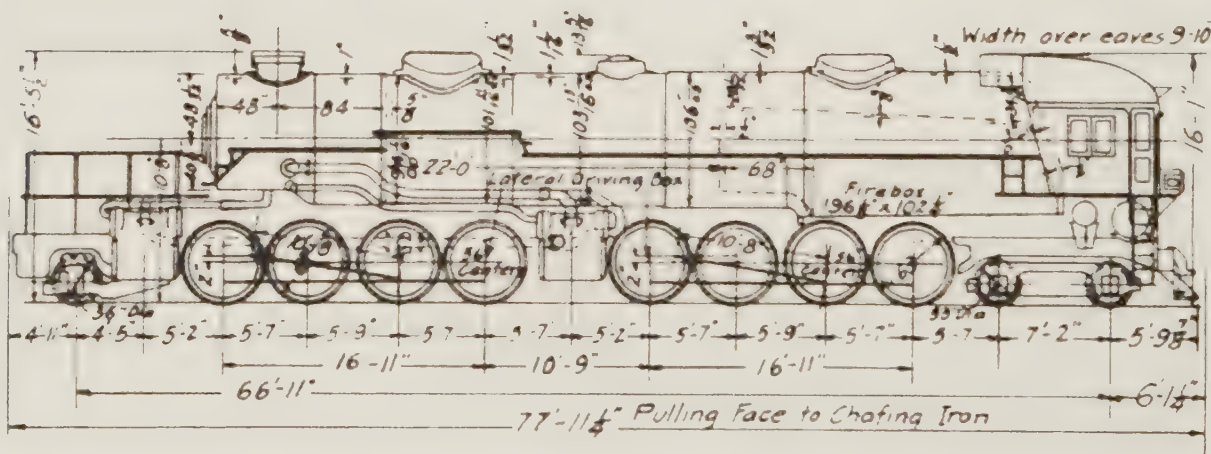
drical tender that had 16,000 gallon water capacity and 4912 gallon oil capacity.

The Southern Pacific placed one more order with Baldwin in 1929. It was for the even heavier AC-6, Numbers 4126-4150. These locomotives sported Vanderbilt tenders, and were the last group to have spoked drivers and the flat cab. Deliveries began in May 1930, with ten locomotives coming out of Eddystone. Five more were completed in July, four in September, October and November. These locomotives operated at 250 psi and had a rated tractive effort of 124,300 pounds.

These represented the first of Baldwin's own brand of Super-Power articulated locomotives, and they were delivered in an era when railroad were not just replacing older locomotives, but replacing them with more efficient power of high horsepower that could pull more cars and use less locomotives, and less fuel per ton to do so.

While Baldwin built the 4-8-8-2 Cab-Forward, American Locomotive Company was working on a 2-8-8-4 design that would see one prototype built for the Northern Pacific Number 5000 in 1928 (Alco c/n 67578).

The prototype locomotive was plagued by significant steam leaks and problems that suggested American Locomotive was not providing reliable locomotives. NP put its inquiries out to



Southern Pacific Cab-Forward AC-4 diagram. This was the first group of modern design Cab-Frowards with a more aerodynamic cab and a four-wheel lead truck.



The revised Cab-Forward, Class AC-7 featured disk driver centers, a punched out cab front and a rectangular tender tank, plus the larger platform monkey deck. This order was built during 1936.

other builders and in 1929, hungry for any order to keep the plants operating, Baldwin fielded the order for 11 additional locomotives Numbered 5001-5011, The bid was awarded based on price. Baldwin was operating in red ink as of this date.

The locomotives were delivered, two in March, five in May, three in July and one in September 1930. Baldwin did not build any more of that wheel arrangement until 1941.

The 2-6-6-4 Development

Baldwin engineers laid pencil to paper as the first of Baldwin's Super-Power locomotives were coming off the erecting shop floor. In their planning they had taken the ideas of Samuel Vauclain's to put more axles under the locomotive, do away with the compounding of steam and make a race-horse with muscle. What come out of the engineering department was a new 2-6-6-4 wheel arrangement with larger diameter drivers of 70 inches, a massive boiler of 106 inch diameter and a rated tractive effort of 108,000 pounds.

The Erie Railroad was approached in January 1929, but declined the opportunity. Is it possible the B & O was included in the solicitation? By the end of the year they had placed an order for two experimental 2-6-6-2s with 70 inch drivers. The first, B & O Number 7450, c/n 61560 with 23x30[4] cylinders was delivered out the west gate in November, 1930, followed by B & O Number 7450, c/n 61571 in January 1931.

Considering these two locomotives had the larger

70 inch drivers would suggest the B & O was interested in a locomotive similar to Baldwin's latest offering.

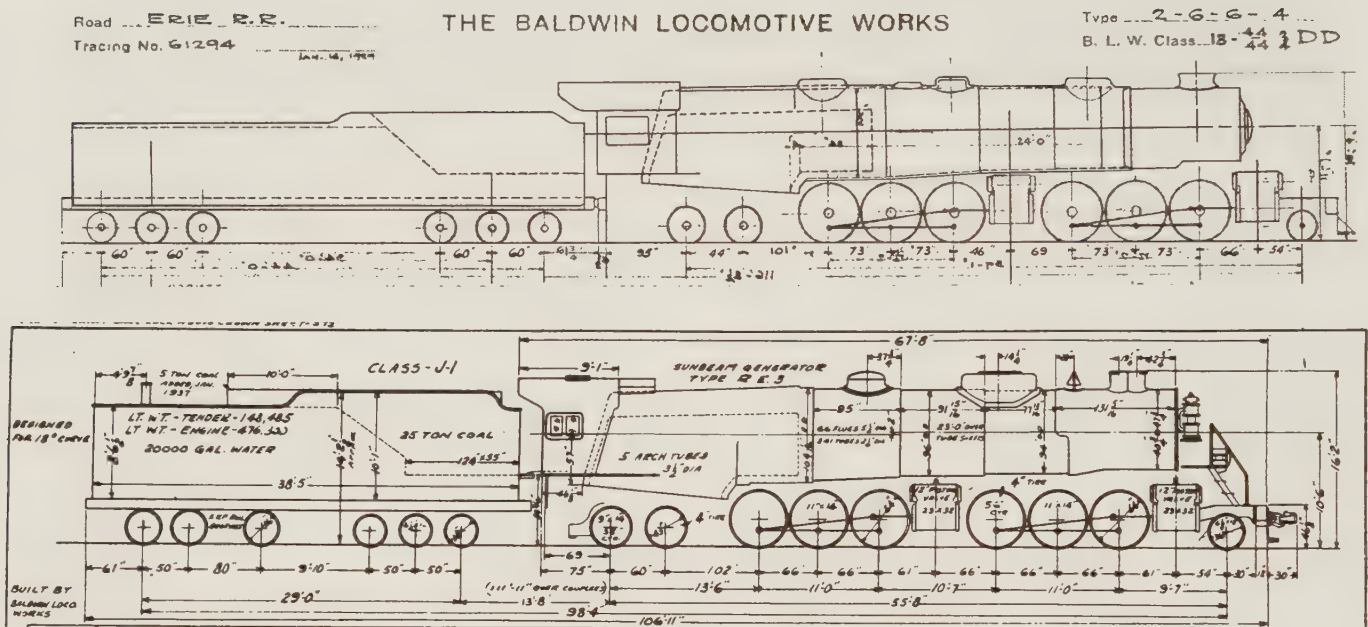
Railroad locomotive superintendents wanted to know, could a simple articulated be designed for *high-speed* heavy freight service? Would an engine with 70-inch drivers be able to handle a big train over a sawtooth profile or across flat lands at track speeds?

The B & O Cumberland Division would be the test bed. Road tests showed the locomotives could handle larger trains than one of the railroad's 2-10-2s, and develop more horsepower. During these initial tests, train speeds did not exceed 35 mph. But further operation at higher speeds revealed a serious front engine hunting problem. The front engine became unstable. The Number 7450 was converted to a 4-4-6-2 in an effort to stabilize the high speed hunting, but it was not a successful solution to the problem.

It was the diminutive Pittsburgh & West Virginia Railway that finally broke the ice. Their locomotive fleet was aging and maintenance expense was increasing, so they started looking around for new power. At first, Baldwin built Bessemer & Lake Erie 2-10-4 Number 605 was brought in but the curves were too tight and derailments of the locomotive were frequent. A Pennsylvania Railroad 2-10-2 was also brought in, but it too proved not to be what the railroad wanted or needed.

At last an articulated was loaned to the railroad, thought to be one of the B & O 2-6-6-2s, and perhaps either Number 7400 or 7450. Its

The 2-6-6-4, Baldwin's Last Articulated Design



2-6-6-4 STATS

Pittsburgh & West Virginia

J-1 1100 - 1102 64" 23x32in(4) 225psi

TE 97,500 lb 528,040 TW with Tender Booster

J-2 1103 - 1106 64" 23x32in(4) 225psi

TE 97,500 lb 523,980 TW without Tender Booster

Seaboard Air Line

R-1 2500 - 2504 69" 22x30in(4) 230psi 150t 218t 96sq.ft. 5513sq.ft. 2397sq.ft. Baker

R-2 2505 - 2509 69" 22x30in(4) 230psi 150t 218t 96sq.ft. 5429sq.ft. 2397sq.ft. Walschaerts

performance was quite satisfactory. The Great Northern Railroad was consulted for the articulated locomotives it operated, along with the Belpaire firebox design. By the end of 1933, Baldwin had received its first firm order for three new 2-6-6-4s from the P & W V, c/n 31788-31790. The locomotives were to have 64 inch diameter drivers, tractive effort of 97,500 pounds and 225 p.s.i. operating pressure. These three were also equipped with a six wheel Bethlehem tender booster truck offering an additional 16,000 pounds of tractive effort. Baldwin offered delivery in the fourth quarter of 1934. Eddystone was almost empty of orders at the time.

The four-wheel trailing truck was required to support the larger furnace. This firebox was critical to producing the high fuel combustion rates required for the successful modern high-horsepower steam locomotive.

The first locomotive, P & W V Number 1100 was completed in late September, 1934, and left for Rook (Pittsburgh), Pennsylvania via the B & O under its own power. The Number 1101 and 1102 followed over coming days. While coming over the B & O it was discovered the four wheel trailing truck stabilized the front engine and gave the locomotive a real advantage.

They were exactly what the P & W V needed, handling the tonnage on the many curves of the railroad at good speed. Their only apparent problem was the high maintenance of the tender booster.

During 1935 the Seaboard Air Line took delivery of five Baldwin 2-6-6-4s Numbered 2500-2504 c/b 31829-31833. They used the larger 69-inch drivers but with a reduced tractive effort of 82,300 lbs.

The SAL gave their engines a chance to stretch their legs and do what Baldwin engineers had looked for in 1928. The locomotives routinely moved time-freight at 60 mph or better.

The P & W V came back for two additional locomotives during 1935, the 1103 and 1104 c/n 61950 and 60951, coming into service during 1936. A final order was placed for two additional units in 1936, the Number 1105 and 1106 c/n 62016 and 62017. They were delivered in 1937.

Seaboard was very satisfied with the locomotives and ordered another five in 1937, Numbered 2505-2509 c/n 62054 - 62058. No more 2-6-6-4s were ordered by any railroad and it closed the era of Baldwin articulated locomotive designs.

Baldwin Super-Power

Baldwin began the production of many heavy mainline locomotives with the four-wheel trailer truck provided by outside suppliers. The four wheel trailing truck being largely used as the visible marker of a Super-Power era locomotive.

While Baldwin had been the largest manufacturer of conventional locomotives it lacked the drive to become a leading innovator in new locomotive designs that provided greater work in the same or smaller framework. It was eight years behind Lima Locomotive with Super-Power development.

Joel Coffin, a large owner in steam railroad and industrial steam manufacturers, led his holdings, including Lima Locomotive Works, into an era of invention emphasizing locomotive efficiency,

this was immediately following WW I. Wil Woodard of LLW put on the table in 1918, for the USRA mechanical design committee, his plan for a four wheel trailing truck to be placed under the heavy USRA 2-8-2., but the idea was rejected. It proved to haunt both Baldwin and American Locomotive.

With the larger furnace area in a Super-Power boiler, it required the four wheel truck. Baldwin had put four-wheel trucks under Central Railroad of New Jersey, CNJ Road Number 225 c/n 57387 4-6-4T in November 1923. Its purpose was not to support a larger furnace, but to provide stability for the locomotive when moving in reverse.

Super-Power went on to extend and use the four-wheel trailing truck as a means of locomotive load distribution via springs and equalizers, this making the truck a direct articulated extension of the locomotive frame. This was a new concept to traditional locomotive designers.

American Locomotive Company was the second of the Big Three builders to adopt the four wheel trailing truck, applying it to New York Central 4-6-4 Number 5200 on February 9, 1927, at their Schenectady, New York plant. Then just two weeks later four 4-6-4's rolled out the doors at American Locomotive's Brooks plant, destined for the New York Chicago & St. Louis Railroad (Nickel Plate Road).

Baldwin's entry into the Super-power era came two months later when its first main line steam employing the four wheel trailing truck and concepts of Super-Power rolled out the Eddystone door in April.

The Atchison, Topeka & Santa Fe Railroad had been interested in four wheel trailing truck design since 1919 and jumped in with an additional order for locomotives employing the new truck and other locomotive improvements with their order for fourteen 2-8-4s in April and May, 1927, Numbers 4101-4114 c/n 59952-55, c/n 59977-78, c/n 59988-92 and c/n 60029-60032. These were also the first of the "Berkshire" wheel arrangement to roll out the doors at Eddystone.

Over the life of that wheel arrangement most were built by Lima Locomotive Works.

Its initial production run for the 4-6-4s were an order for 15 for the Atchison, Topeka & Santa Fe Railroad Ten, Numbered 3450 - 3454 c/n 59993-59997 and having 73 inch drivers being delivered in April. An additional five, Numbers 3455 - 3460 were delivered in May.

The first 4-8-4 built by Baldwin was ATSF Number 3751, delivered with 73" drivers in May, 1927, at a price of \$99,712.77. The Santa Fe took nine more Numbers 3752-3760 in January and February 1928.

This prototype locomotive was designed jointly by Baldwin, Santa Fe Mechanical Engineer H. H. Lanning and staffs. It featured the newly developed Type E superheater, 30 x 30-inch cylinders and 73-inch drivers. Starting tractive force was estimated at 66,000 pounds.

This locomotive was equipped with one-piece cast steel cylinders which were keyed and bolted to the cast one-piece locomotive bed. Appliances included American multiple throttle, Elesco feedwater heater, Nicholson thermic syphons, Ragonnet power reverse gear, Walschaerts valve gear, Duplex stoker and Santa Fe's patented Layden four-ported exhaust nozzle.. The tender was equipped with a Commonwealth one-piece cast steel underframe with six-wheel trucks. The tender was designed to hold 15,000 gallons of water and 20 tons of coal..

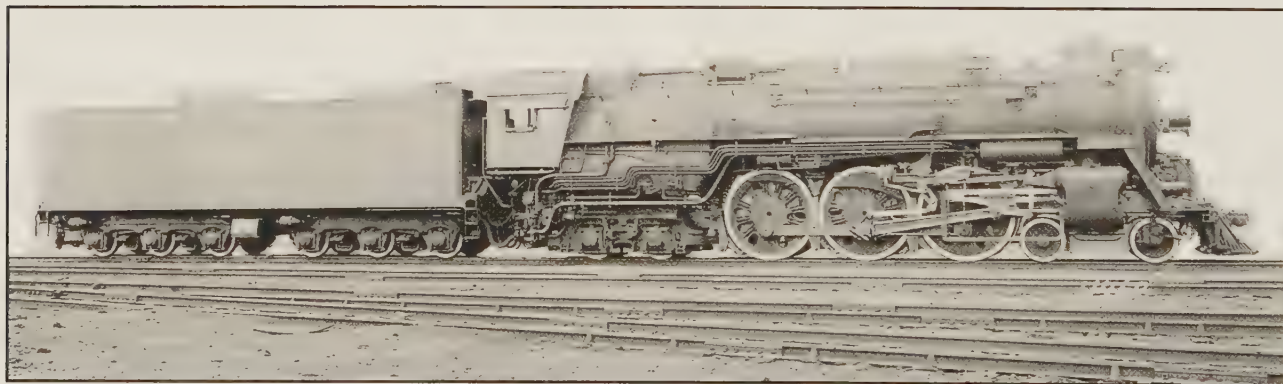
The main drivers were cross-counterbalanced

with static wheel load of 67,350 pounds. Total engine weight was 421,900 pounds; the tender loaded, weighed 283,000 pounds.

After a few months of testing nine additional 4-8-4's, Nos. 3752-3760 c/n 60328-60334 and c/n 60385-60386 were ordered, with delivery being made in January and February 1928. Locomotives Numbers 3752-3756 were delivered with Dupont stokers and Franklin Butterfly firedoors. Locomotives 3757-3760 go Duplex stokers and vertical firedoors.

The next year, 1929, the Atchison, Topeka & Santa Fe Railroad placed another order for four more of the 4-8-4s. Their Numbers were 3761-3764 c/n 60764-60766 and c/n 61091, the first three of which rolled out the doors of Eddystone in April 1929. The Number 3764 followed five months later in September. All four engines were equipped with Standard stokers, but three came with the Walschaerts valve gear. The Number 3764 was delivered with Baldwin's Caprotti poppet valve gear. Equipping the engine with poppet valves took the additional time since the cylinder castings had to be greatly modified as did the rod and control box arrangements. Reports suggest the installation of the poppet valves added an extra \$1977.73 to the bill. The base price for the four locomotives \$102,302.06 each.

Samuel Vauclain had taken a particular interest in many of the Caprotti inventions including his poppet valve control system and a unique main rod arrangement. This Santa Fe application was



Atchison, Topeka & Santa Fe, 4-6-4, Numbers 3460-3465 c/n 62083-62088 had massive 84 inch drivers and were delivered in 1937

fully ten years ahead of Franklin's entry with its Woodard designed poppet valve gear and the experiment application to the Pennsylvania Railroad 4-6-2.

Baldwin's entry with the 2-10-4 came with an order from the Chicago, Burlington & Quincy for two Numbers 6310-6311 delivered in September 1927. Four more rolled out the shop doors in October, Numbers 6312-6315 c/n 60252-60255. These locomotives had 64 inch drivers.

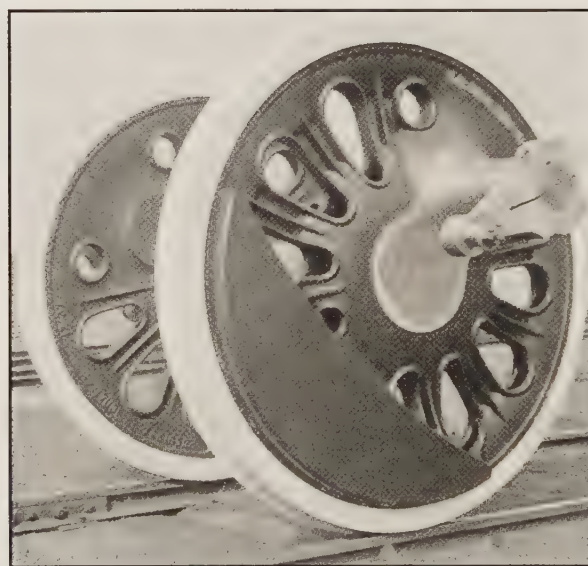
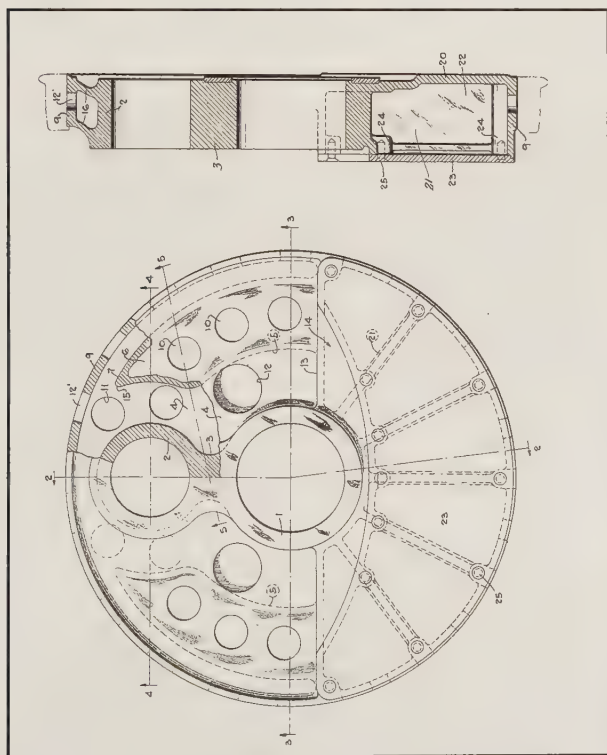
No more 4-6-4s were ordered until 1930, when the Chicago, Milwaukee, St. Paul & Pacific (Milwaukee Road) ordered 14, Numbered 6400-6413 c/n 61135-61148, these came with 80 inch drivers and were delivered in January-March 1930. By this point The Baldwin Locomotive Works was losing a great deal of money and the norm of manufacturing locomotives in lots of five was suspended. Locomotives were built as orders came in. Baldwin had resorted to significant

layoffs by this time as it scrambled to keep the forges warm.

The bulk of Baldwin's Super-Power focus were in four wheel arrangements of, 4-8-4, 2-10-4, 2-8-8-4 and Southern Pacific's unique 4-8-8-2 cab-forward design. It amounted to a total of 743 engines or 77% out of the 965 of that style of locomotive built in the Eddystone shops. Other Super-power wheel arrangements produced there included 4-6-4, 2-8-4, 2-6-6-4, 4-6-6-4 and 4-4-4-4 wheel arrangements. There was also the sole 6-8-6 steam turbine.

Baldwin built 31% of Super-power design locomotives used on United States Railroads. They had long enjoyed just over 50% of the locomotive market, but it was caught completely off-guard when Coffin's Lima Locomotive introduced the many advantages of Super-Power and grandly splashed it's successes in the trade press in 1925.

Baldwin continued to enjoy diminished export business for conventional locomotives, along with American Locomotive, but Lima as the new-comer did not. Baldwin also had a strong market for its industrial electric mules, built in conjunction



On the left is an illustration from Baldwin's highly acclaimed and successful Baldwin Disc Driver (US Patent 2,065,217, issued December 22, 1936). It did much over conventional spoked driver centers to reduce the effects of dynamic augment in the age of Super-Power locomotives. RIGHT is a photo of the 80 inch disc driver used on the Atlantic Coast Line Railroad 4-8-4 Class R-1 and delivered in 1938.

with Westinghouse

With the Locomotive 60000 experiment being an acknowledged failure, Baldwin entered the Super-Power steam era somewhat hamstrung by the many inventions and improvements of other builders, principally Lima Locomotive; to a lesser degree American Locomotive and even outside component suppliers such as Commonwealth Steel. It put Baldwin in a very precarious position since much of the grand markets they had enjoyed in the past were gone.

Baldwin had to bring some improvements to the market. They appear to have begun by addressing dynamic augment. Thomas W. Fawcett, a mechanical engineer contracting with Baldwin was involved with cross-balancing engines at least as early as May 1927. American Locomotive Company was quite busy with several driver center designs of its own.

It appears the Santa Fee took the first Baldwin built locomotive with cross-balanced drivers in the Number 3751. The Great Northern Railway locomotives of the S-1 class 4-8-4s Numbered 2550-2555 c/n 60781-82 and c/n 60807-60810 were delivered in April and May 1929, with cross-balanced 73 inch (spoked) driver centers. In February 1930, the GN S-2 class 4-8-4s Number 2575-2588 c/n 61211-61216 and c/n 61224-61225 and c/n 61237-61242 were delivered with even larger 80 inch drivers, also cross-balanced. The locomotives were highly praised for their overall operation pulling the *Empire Builder*.

Baldwin recognized it was in a new era of brute power after the introduction of Lima's

Super-Power in 1925 and many of the traditionally accepted rules of steam locomotive design and operation had been disproved.

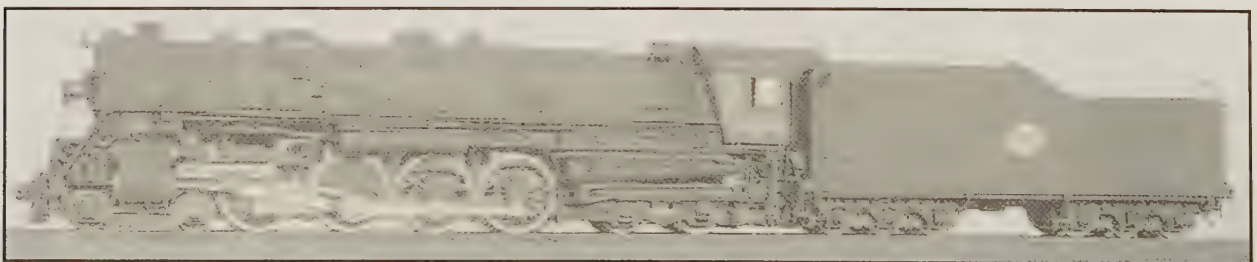
Fawcett made patent application on April 13, 1933, for an improved form and arrangement of elements in what he described as a semi-disc cast type driver center.

Fawcett understood the severe service conditions of driver centers from the standpoint of resisting load and impact forces and also the driving forces applied to the crankpin. The radiating spokes were the weak link in the existing driver center casting.

He claimed, and quite correctly, that if the spokes were made heavier it would cause greater difficulty with improper weight distribution and serious difficulty effecting proper counterbalancing.

The driver center was essentially redesigned, eliminating the spoke and shaping a driver center that gave more favorable weight distribution and an ability to provide a more perfect counterbalancing while ensuring strength of the casting.

Fawcett, in his words describes how his design would accomplish this task: "I specifically accomplish the forgoing object by providing a semi-disc type of driving wheel with a double wall hollow portion immediately surrounding at least a portion of and preferably both the axle and crankpin hubs at their point of juncture, whereby said hubs may be made not only considerably lighter in weight than has heretofore been possible in practice but also the juncture of said hubs may be considerably necked down, thereby appreciably reducing the weight in the crankpin side of the



Chicago & Northwestern 4-8-4 Number 3001-3002 c/n 60986-60987 with 76 inch drivers the first two were built in August, 1929.

wheel without reducing the strength thereof. As a result of this improved construction the wheels may be effectively counterbalanced against the driving mechanism on each side of the locomotive, this being impossible with prior art wheels, under certain conditions, because of the large amount of weight in the crankpin side of the wheel which is necessary to insure proper strength in such wheels.”

The Baldwin Disc driver were introduced in 1936. It was well received, but there were few locomotives being ordered at the time.

During 1937 the Association of American Railroads praised the Disc driver for its ability to reduce dynamic augment which led to improved riding qualities and also reduced hunting.

Baldwin did acknowledge in 1940, that large 4-6-4 and 4-8-4 engines had a problem with oscillation, and Charles Damsky of the engineering department was sent in to investigate, he found the problem to be overbalance, and was proved correct in later slip tests after the excess

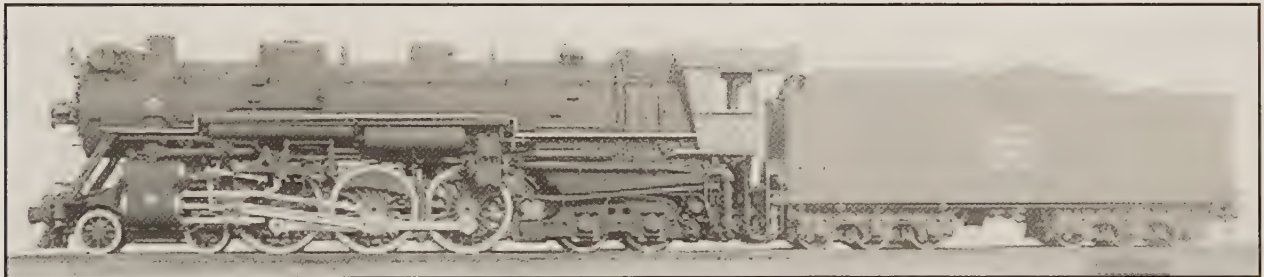
weight was removed.

In the art of locomotive design the emphasis was placed on maximum power and durability of equipment. New locomotives were unmatched for size and brute power.

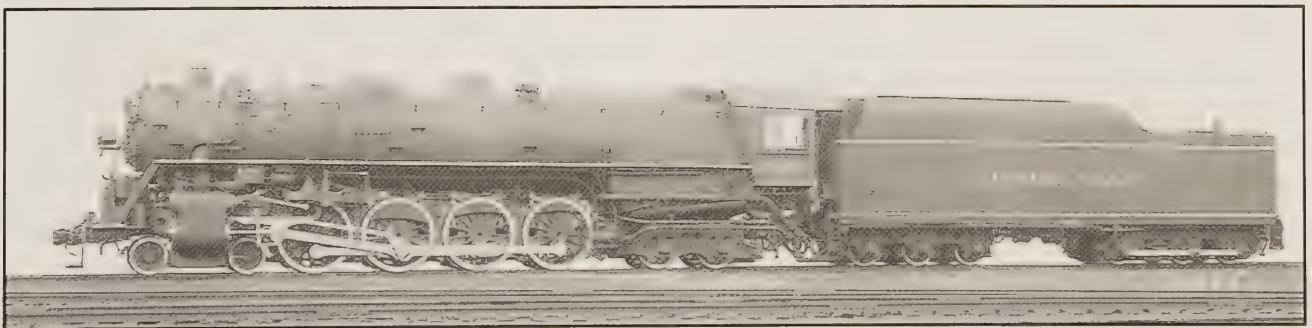
Frames, cylinders, axles, and bearings of these engines were being subjected to ever-increasing dynamic forces. Steam locomotives were required to run longer distances between terminals without change and the with minimal routine maintenance.

Up until the early 1930's, locomotive frames consisted of many separate parts, some cast as long slab units such as frame sides and others cut from rolled form stock. All had to be machined and hand-fitted to form a rigid subassembly.

They were assembled with separate cross-braces, cylinders, bolster and valve gear plat-forms. Cylinders had traditionally been cast as two or three separate pieces which had to be machined, bolted together, and precision-fitted to the frames to ensure a tight fit.



Chicago, Burlington & Quincy 4-6-4 Numbers 3000-3001 c/n 61445-61446 , delivered with 78 inch drivers. They came out the doors of Eddystone July, 1930.



Lehigh Valley 4-8-4 Number 5101 c/n 61615 built March 1931, with 70 inch drivers. It had a six wheel tender booster placed under the rear tender truck. The tractive effort of the booster would have largely been proportional to the amount of water in the tender. LV came back in 1932 and purchased nine more of the locomotives.

Older locomotives had exhibited some problems over time such as bolts that might work loose, which was not uncommon in heavy road service, or over-torqued bolts without an ability to firmly hold. These problems regularly required attention to maintain the frames and cylinders in proper alignment.

By 1930, the Commonwealth Steel Corporation of Granite City, Illinois, had perfected steel casting to such a degree that it became possible to cast the entire frame assembly and incorporate all former individual components in a massive one piece casting of steel. This would greatly reduce floor assembly time at the locomotive manufacturing site as well as minimizing maintenance once the locomotive was in service.

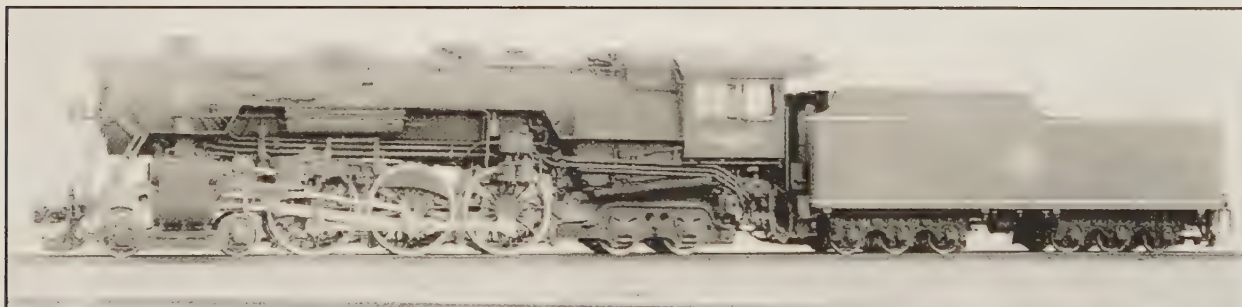
With CSC's entry into receivership, its assets were purchased by a consortium of customers consisting of, The Baldwin Locomotive Works, Pullman Car & Manufacturing Company, American Locomotive Company and American Steel Foundries. They formed General Steel Casting

Corporation. A second plant was built at Eddystone in 1931 to replace a smaller plant of ASF at Chester and to feed Baldwin with integral cast steel locomotive frames and other castings.

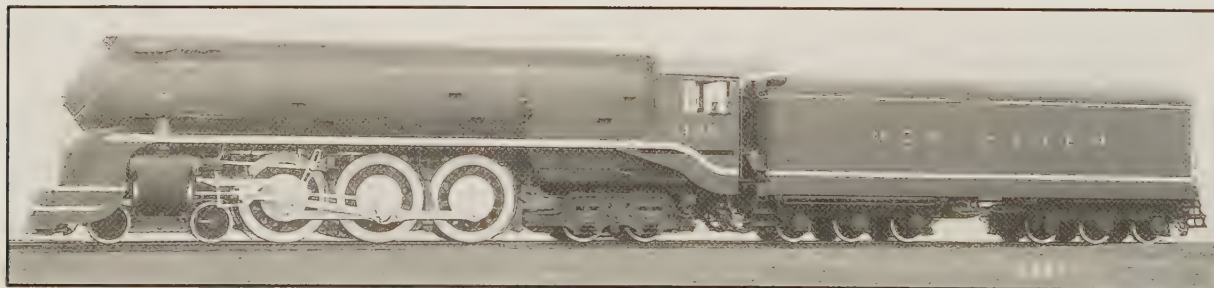
This integral frame typically included the main frames, cylinders, various brackets, and even air reservoir cylinders in a single casting. In combination with roller bearings developed by Timken and SKF, and self-adjusting wedges developed by Franklin, the integral cast bed frame greatly reduced running gear maintenance on many steam locomotives built new or upgraded after 1931.

Baldwin quickly adopted General Steel Castings, integral cast steel "Commonwealth" locomotive bed by early 1930. This changed the course of foundry activity at both Eddystone and Baldwin's Stand Steel plant at Burnham, Pennsylvania and also substantially diminished locomotive frame assembly at Eddystone and associated manufacturing support such as machining and subassembly.

The first locomotives to roll out the doors at



Chicago, Milwaukee, St. Paul & Pacific (Milwaukee Road) ordered 14, Numbered 6400-6413 c/n 61135-61148, these came with 80 inch drivers and were delivered in January-March 1930.



New York, New Haven & Hartford Railroad streamlined 4-6-4 Numbers 1400-1409 c/n 61964-61973 with 80 inch drivers The order for ten locomotives was built in February 1937 and featured a one piece cast locomotive bed with integral cylinders. These were the first streamlined locomotives built in the United States.

Eddystone with intrigal cast steel frames were a group of eight 4-8-4s ordered by the Southern Pacific for its Texas & New Orleans subsidiary c/n 61390-61391, c/n 61408-61415 and c/n 61430-61433, in early 1930. These frames were cast at Granite City, Illinois, and shipped to Eddystone, Pennsylvania. A year later, the cast steel beds would be coming from a new GSC plant just across Essington Avenue in Eddystone.

The Eddystone Heavy Electrics

The age of the heavy electric jack-shaft locomotive was largely over before the development of Eddystone as a locomotive manufacturing site.

Baldwin continued to build the car bodies and by arrangement with Westinghouse Electric Manufacturing Company. Electrical apparatus was installed at either its East Pittsburgh or South Philadelphia plants.

The year 1927 saw an order for five electrics of the 1-C-1+1-C-1 arrangement, New York, New Haven and Hartford Railroad Numbers 0322-0326, delivered in July. The Great Northern took two 1-D-1 electrics Numbered 5000A and 5000B, delivered in December 1927 and January 1928.

There were no more heavy electric orders until the Chilean State Railway ordered four 1-C-C-1 Numbered 2807-2810 and delivered in June 1930.

The next order came when Baldwin was at its weakest moment during the peak of the depression. Hometown road Pennsylvania Railroad ordered 54 P5a electric bodies of the 2-C-2 type. The order was spread over three years as follows: bodies for Numbers 4701-4732 were built starting in June 1932, and running through the end of the year. Numbers 4733-4741 were built in 1933, and Numbers 4742-4754 were built in 1934. All were taken up the tracks to WEMCO's South Philadelphia plant for installation of the electrical apparatus.

The P5 patents were spread across several including Wil Woodard of Lima Locomotive,

Winston Brecht of WEMCO and Robert Miller of the Pennsylvania Railroad.

During the summer of 1934 a consortium that included Baldwin, Westinghouse, General Electric and other significant contractors to the Pennsylvania Railroad drew up the specifications for the prototype 2-C+C-2 heavy electric, classified as a PRR GG-1 and Numbered 4899. Baldwin built the empty body and it was rolled out the doors of Eddystone in August 1934. The car body was shipped to General Electric at Erie, Pennsylvania, for installation of the electrical apparatus.

The PRR also ordered a prototype 2-D-2 Number 4800, which was rolled out in September 1934.

The prototype GG-1 proved itself quite successfully. Baldwin was ask to provide additional carbodies to be shipped to PRR's Juniata Shops for final assembly. These units Numbered 4815-4839 were shipped between April and July 1935.

Their massive frame was a one-piece casting poured across the Street at General Steel Castings. The patents on the frame were held by Baldwin (U.S. Patent 2,076,231 issued April 6, 1937).

After a long dry spell, the New York, New Haven and Hartford Railroad ordered five 2-C+C-2 electrics, Numbered 0150-0154, delivered in October 1941.

During 1943, Baldwin moved all of its small industrial electric mule production to Whitcomb and exited the business entirely. The significant production of the industrial electric mules was 1942. After that time only four were built at Eddystone, two 30 inch gauge 24 horsepower units for the Chile Exploration Company in 1943, c/n 69729 and 69730. A single 42 inch gauge 30 horsepower unit for Elcomb Coal Co., c/n 69741 and a 48 inch gauge 300 horsepower unit for Jones & Lasughlin Steel in March 1944, c/n 70177.

Baldwin did not build any heavy electrics for five years, until after the end of WW II when the National Railways of Mexico ordered 14 2-

C+C-2 units of 3,000 horsepower, delivered between April 15, 1947 and July 20, 1948. c/n 72672 -72685

The last heavy electrics Were B-L-H-West-
inghouse units that went to the Pennsylvania Rail-

road as two B-B-B units Numbered 4995 and 4996 in June 1951 and two C-C units Numbered 4997 and 4998, delivered in July 1951, c/n 75482 -75485.



Milwaukee Road box cab electric locomotive. The car-body and running gear was built by Baldwin. The electrical apparatus was manufactured and installed by Westinghouse Electric.



Passenger box cab electric built in 1921 for the Paulista Railway of Brazil. -- Both photos from BLW

The Baldwin Locomotive Works

Major Holdings and Products

Circa 1931

The Baldwin Locomotive Works

Steam locomotives
Gasoline-mechanical locomotives
Electric locomotives
Electric mining and industrial locomotives
Diesel-electric locomotives
Scale cars
Tenders
Ordnance
Castings
Forgings
Trucks
Drivers
Axles
Repair and replacement parts

Baldwin-Southwark Corporation

Castings,
Stationary steam engines,
Presses,
Machine tools
Forgings

Cramp Brass and Iron Foundries Co.

Diesel engines
Hydraulic machine presses
Plate rolls
Plate planers
Ship propellers
Ship propeller shafts
Ship steering gear
Steam turbines
Hydraulic turbines
Brass and bronze castings
Iron castings
forgings

DeLaVergne Refrigeration Machine Company

Diesel engines
Commercial refrigeration compressors

Pelton Water Wheel Company

Hydraulic turbines
Water driven turbines
Hydraulic valves

Whitcomb Locomotive Works (92% ownership)

Electric mine locomotives
Gasoline-mechanical locomotives
Electric trolley locomotives
Gasoline-electric locomotives
Diesel-electric locomotives

The Midvale Company (60% ownership)

Driver tires
Seamless steel rings
Forgings
Heat and corrosion resistant castings
Ordnance and armor plate

Standard Steel Works

Rolled steel wheels
Steel forgings
Steel castings
Gears
Springs

Baldwin Locomotive Securities Corporation

Financial instruments and services

General Steel Casting Corporation (25% ownership estimated)

Heavy steel locomotive and car castings

The Baldwin Diesels

Harold L. Hamilton, President of upstart Electro-Motive Engineering Company* had called on Baldwin in the mid-1920's seeking to discuss the potential production of their conceptual diesel-electric railcars with Baldwin president Samuel Vauclain.

Hamilton and his partner Paul Turner, were the incorporators of Electro-Motive Engineering Company on August 31, 1922, at Cleveland, Ohio. They waded into the railroad motive power business with nothing more than a concept to sell distillate engine powered rail motor cars. They did not manufacture their locomotives nor any component used on them, rather subcontracted the work to other equipment and apparatus suppliers and railcar builders. This proved to be a key to their future success.

During 1923, EMEC drew a scant two orders from the Chicago & Great Western and Northern Pacific Railway. Sale of these two units were conditional that the motor cars had to perform as specified and they had to run for 30 days in revenue service with no more than two, 15 minute delays for mechanical problems. Payment was contingent upon meeting the performance criteria. The cars were delivered during the summer of 1924, and successfully passed their service tests.

During 1925 EMEC took orders for 27 of the self-propelled motor cars. Creative juices were flowing that would dramatically change motive power on the railroads from steam to diesel-electric. EMEC owners lacked the working capital required to enter the diesel-electric railroad locomotive market as manufacturers and

compete against established steam technology. They were completely at the mercy of performance of new technology and their own designs.

Thus Hamilton was solicitous of Vauclain and his interest in exploring an agreement to build some portion or all of their diesel-electric railcars and possibly other more extensive business exploration. Although the date of these conversations is lost to history, there are indicators it was circa 1926, just after the introduction of Baldwin's prototype experimental diesel-electric BLW 58501. These discussions were completely independent of the future time when EMEC would become a holding of General Motors Corporation.

Vauclain was very pro-steam, he was wrestling with many major management challenges for which he may not have been fully prepared at the time Hamilton showed up.

During 1925, former Baldwin employee William E. Woodard, Vice President, Engineering, for Lima Locomotive Works and his design team had just introduced the highly successful *Super-Power* line of steam locomotives, which began carving into Baldwin's declining locomotive markets. Vauclain and his designers responded with the Locomotive 60000, rights to build the Caprotti poppet valve gear and beefed up articulated locomotive designs, triple expansion steam (May 17, 1927 Patent 1,629,370 and Patent 1,629,369) and his slope cylinder 2-12-2 with Caprotti patents (June 17, 1930 Patent 1,765,251 and Patent 1,765,291.) On both accounts the approach for maintaining existing customers or gaining new business was incorrect. Thus Vauclain, by maintaining status-quo was being attacked by progressing technology that would knock Baldwin off its perch.

In the background was the issue of allegiance

*June 20, 1930, General Motors Corporation purchased marine and railroad diesel builder, Winton Engine at Cleveland, Ohio. On December 31, 1930, Electro-Motive Engineering Company joined the expanding portfolio of General Motors Corporation.



Baldwin 58501, a 1000 horse power experimental Oil-Electric locomotive of A1A+A1A wheel arrangement built June 25, 1925. It weighed 276,000 pounds.

to Westinghouse, who had long supported Baldwin, with both electric apparatus for electric locomotives, air brakes and electric gear for the machines at the plants since 1896. There was the fact that EMEC was using electric gear from General Electric, arch competitor to Westinghouse, who held a seat on the Baldwin board.

Vauclain was quite familiar with the nature and advantages of electric traction, its application had been known for over forty years. But at this date railroads were pressing the steam builders to strive for 1,000 horse power per axle, and any suggestion of new technology that could only generate a total of 300 hp to 600 hp across four axles seemed perhaps a bit absurd.

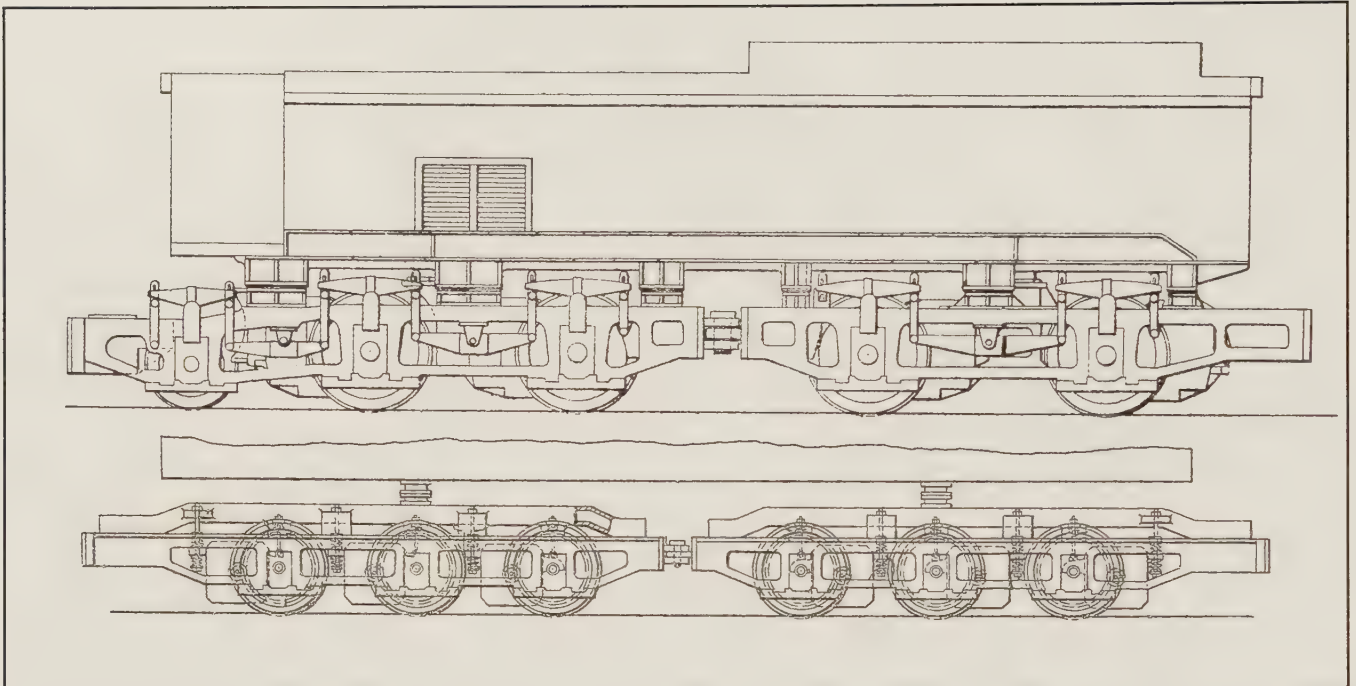
Hamilton's appearance at Baldwin was the right opportunity but presented at a time when those steeped in tradition failed to recognize the profound nature of his proposals and the significant impact it would have on all steam builders in

the near future.

Baldwin's Reluctant Entry into Diesel-Electric Locomotive Production

Baldwin's entry into the field of diesel (oil-electric) locomotives is recorded as having occurred on June 25, 1925, when experimental Baldwin oil-electric locomotive Number 58501 was rolled out the doors. The 52-foot boxcab put together some component systems of Baldwin's own design as well as significant of those of Westinghouse Electric Manufacturing Company, WEMCO. The significant role of Westinghouse in Baldwin's future diesel-electric product line was set at their very entry into this new technology.

Three men, Norman Storer, Herbert Herr and Harold Houston of Westinghouse led the drive for heavy diesel-electric locomotive devel-



This view is of two early Westinghouse Electric and Manufacturing Company patents that were filed in 1922, covering the trucks, cab and carbody structure of a diesel-electric locomotive. Both predate the construction of BLW Number 58501 by just over two years. With many lines in these patents following that of the 58501 is to suggest that Westinghouse took the lead, and not Baldwin in the development of a heavy diesel-electric locomotive. Note three truck configurations are illustrated, a four-wheel power truck similar to that used under BLW Number 61000, a four-wheel power truck with lead idler axle and a six-wheel truck similar to that used under the BLW Number 58501. Both patents were by Norman Storer of Westinghouse. Top illustration from US Patent 1,575,016 filed September 19, 1922. Bottom illustration from US Patent 1,515,228 file December 27, 1922.



Baldwin 61000 was the second experimental oil-electric locomotive. It was also 1000 horse power but of the B+B wheel arrangement built May 15, 1929. It weighed 270,000 pounds.

opment that ultimately impacted Baldwin. These men and this firm guided Baldwin into the new diesel-electric locomotive market. Between the three they held over 50 recent patents covering every aspect of the early diesel-electric locomotive development.

Storer was designing electrical transmission systems and locomotive structures, Houston was heavily involved with trucks and aspects of the locomotive car body, Herr was the diesel engine man about eight years before Baldwin purchased the De LaVergne diesel engine.

The Baldwin Locomotive Works was not supporting the diesel-electric technology even though it had manufactured electric railway trucks and heavy electric locomotive bodies. It was a steam locomotive manufacturer with a long reputation and had been recently threatened by Lima Locomotive Works with their entry into main line steam locomotives and new *Super-Power* developments.

An incident which occurred during the early 1920s is telling in this regard. Baldwin president Samuel M. Vauclain was reportedly making the rounds of the company drafting department when he came across a designer working on plans for a diesel-electric that was to have been the company's first engine of that type. Upon learning that the prototype would be rated at 300 horsepower, Vauclain ripped the blueprint from the drawing board, telling the draftsman, "*Young man, Baldwin never builds horsepower in hundreds, we build in thousands.*"

The team of Baldwin engineers who devoted the initial efforts toward the new technology was headed by Conrad C. C. Burkhardt, with support from Harry Glaenzer and Allen Wallace.

The BLW 58501 was carried on heavy six-wheel trucks more akin to a modified bar frame used under steam locomotives and patented by Westinghouse. It reportedly used a 1000-h.p. Knudsen inverted-vee 12-cylinder two-cycle engine, a rather strange design. Electrical gear including the traction motors and generator was from WEMCO. It likely used an air throttle

designed by Burkhardt.

The Burkhardt Air Throttle was first used by WEMCO in its two licensed Canadian National Railway units built of the 2-D-1 wheel arrangement. The throttle was patented February 25, 1930 (U.S. Patent No. 1,748,829) and employed an air valve throttle control stand and an air piston on the diesel to control the mechanical linkage to the diesel fuel rack.

Road tests of the BLW 58501 on both the Pennsylvania Railroad and the Reading Railroad were strictly for testing of the capabilities of this unit. There were several shortcomings rendering it not suitable for regular service.

By late 1926 plans were under way for a second experimental oil-electric locomotive. A series of patents shows the refinements made as a result of the BLW 58101 tests. They included four-wheel trucks, better cooling and substantially modified frame support. A mysterious order for seven 600 horsepower diesel-electric locomotives shows up on the books for 1927. The order is covered by Baldwin Construction Numbers 60009 - 60015 for the Texas-Mexican Railway in a B - B wheel arrangement. The order was not built by Baldwin at the time, for reasons that are unclear. In 1939, the order again shows up, this time on the books of Baldwin's subsidiary, Whitcomb Locomotive Works, with the same assigned construction numbers and a D wheel arrangement. They were eventually built at Rochelle, Illinois.

Baldwin-Westinghouse Locomotives

Westinghouse took the lead in promoting a line of early diesel-electric locomotives utilizing Baldwin for little more than a design and fabrication shop to assemble the carbody essentials. Under prior arrangement Baldwin manufactured the car-body and Westinghouse shipped the empty body to its East Pittsburgh Works for finishing. Starting in December 1930, the bodies were moved up the track about a mile to the Westinghouse South Philadelphia plant for installation of

The Baldwin-Westinghouse Early Diesel Production

C/N	Date Blt.	Type	H.P.	NOTES
58501	6/25/1925	Box cab	1000 hp	C-C Baldwin Experimental Demonstrator #58501
60185	9/1927	Box cab	330 hp	B Long Island RR #403A
60186	9/1927	Box cab	330 hp	B Long Island RR #403B
60280	12/1927	Box cab	150hp	B Long Island RR #322 "Shop Dinky"
60676	11/1928	Box cab	300hp	B-B WEMCO for:
				Western Electric Co #1
60759	8/1929	Box cab	300hp	B-B Baldwin Locomotive Works #2, Eddystone, Pa
				Armco Steel Corporation #B 70
61000	5/1929	Box cab	1000hp	B-B Baldwin Demonstrator #61000
61261	5/1930	Visi. Ctr cab	800hp	B-B WEMCO Demonstrator #23
				Northampton & Bath #801
61262	5/1930	Visi. End cab	400hp	B-B WEMCO Demonstrator #21
				Westinghouse East Pittsburgh (Pa) Works #9
61263	12/1930	Visi. End cab	800hp	B-B WEMCO Demonstrator #8
				Westinghouse East Pittsburgh (Pa) Works #8
61264	7/1930	Visi. End cab	800hp	B-B U. S. Steel Co-American Steel & Wire Division, #1, Newburgh Steel Works, Cleveland, Ohio
61361	9/1930	Visi. End cab	300hp	B-B Great Lakes Steel Corporation #1
61396	6/1930	Visi. End cab	400hp	B-B Great Lakes Steel Corporation #1st 2
61401	6/1930	Visi. End cab	400hp	B-B Armco Steel Corporation #B71
61600	12/1930	Center cab	300hp	B-B Illinois Steel Corporation #50
61742	1/1933	Center cab	530hp	B-B WEMCO - for Cheswick & Harmar #5
61750	9/1933	Visi. Ctr cab	800hp	B-B WEMCO #12, Demonstrator
				Northampton & Bath #802
61757	1/1934	Visi. End cab	800hp	B-B WEMCO #13, Demonstrator
				Chicago Great Western #2 - 12/1934
61983	8/1936	Visi. End cab	530hp	B-B WEMCO c/n A062 Great Lakes Steel Co #2nd 2
61984	8/1936	Visi. End cab	530hp	B-B WEMCO c/n A063 Great Lakes Steel Co #4
61985	8/1936	Visi. End cab	530hp	B-B WEMCO c/n A064 Great Lakes Steel Co #5

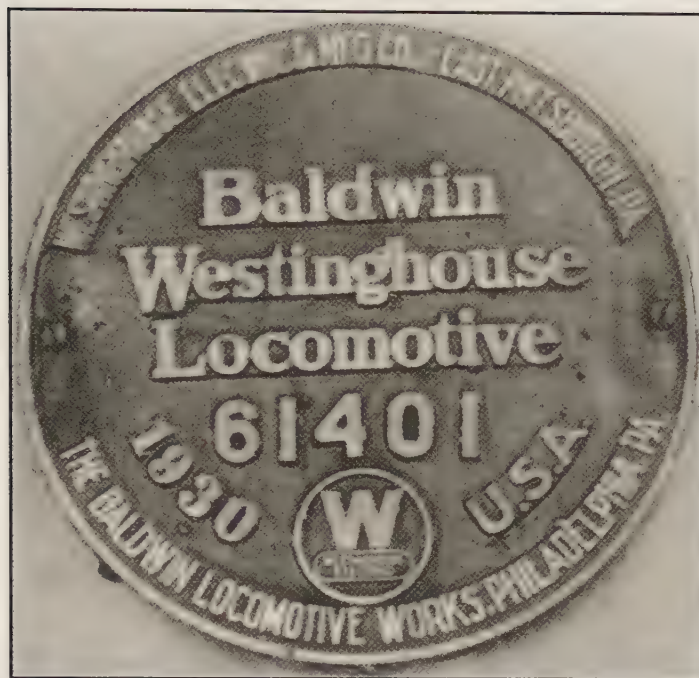
electrical apparatus and finishing.

During late 1926 or early 1927, Westinghouse solidified their efforts to enter the youthful diesel-electric market with the formation of their Railway Engineering Department. In many ways it mirrored the earlier efforts of Electro-Motive Engineering Company. Westinghouse developed talent and perfected designs for early diesel-electric locomotives. It had what EMEC did not . . . the important manufacturing capability to manufacture and assemble all of its electrical apparatus in-house, including exciters, generators, traction motors, control switches and so on. It had an established relationship with the world's largest locomotive builder, The Baldwin Locomotive Works, and had licensed the Scottish diesel, Beardsmore to power its engine-generator sets. EMEC on the other hand had to be both

resourceful and creative in order to try and enter an untested market for railroad motive power of a profound and incremental new technology. It lacked even modest facilities to do the smallest work and relied on suppliers for all mechanicals, electricals and even construction of the finished locomotives. Yet this firm was able to successfully overcome established giants and develop loyal customers and solid reputations.

Baldwin's first contract for a Westinghouse diesel-electric locomotive were c/n 60185 and 60186, 330 horsepower "B" type wheel arrangement box cabs, in September 1927. They were built for the Long Island Railroad as Numbers 403A and 403B. They were semi-permanently coupled.

The two locomotives, nicknamed "Ike" and "Mike" were two prototype diesel-electric loco-



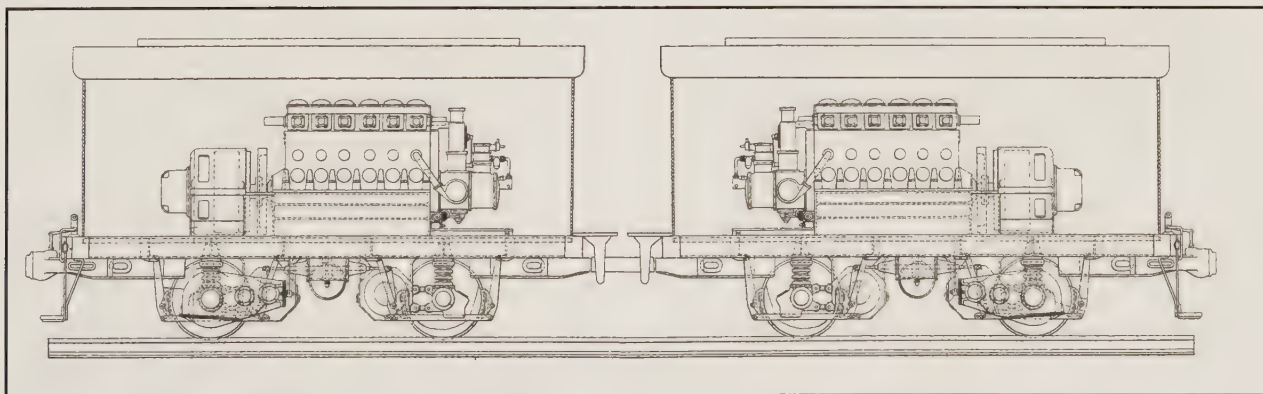
Baldwin Westinghouse builder's plate with Baldwin Construction Number 61401 built June, 1930. It was for a visibility end-cab locomotive of 400 horsepower and was sold to American Rolling Mill Co. (ARMCO) Columbia Division in Butler, Pennsylvania as their Number B71. The locomotive survives at this writing at the Minnesota Transportation Museum. -- Photo by Author September 1971 at Lake City, Michigan, on the Cadillac & Lake City Railroad.

motives designed by Westinghouse Electric and Manufacturing Company with some significant unique differences. It was actually an articulated frame locomotive, made up of two completely independent units semi-permanently coupled via a drawbar.

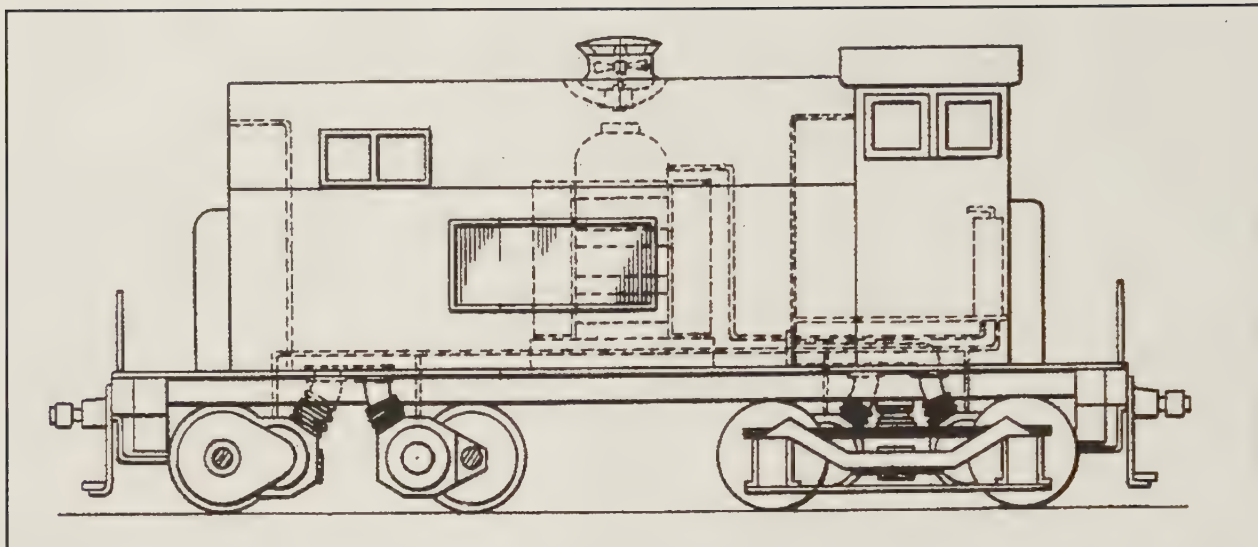
The frame was uniquely designed and received a patent by Norman W. Storer of Westinghouse dated April 17, 1934. U. S. Patent 1,955,314. It was designed to have the main locomotive frame, diesel crankcase, generator frame, traction motor frames and air brake cylin-

ders cast as an intrigal unit, similar to the foundry practices adopted about 1930 for steam locomotive frames.

The railroads and locomotive builders had recognized significant benefits from casting steam locomotive frames with complete engine cylinders, air brake cylinders, valve gear frames, air tank brackets and pump brackets all cast as a single unit. The frames for *Ike* and *Mike* were cast at Eddystone, Pennsylvania plant of General Steel Castings and Baldwin Locomotive Works provided car body assembly. The two units were



Traced from the patent drawings is this rendition of "*Ike*" and "*Mike*" the 330 horsepower prototype diesel-electric locomotives designed by Westinghouse Electric and Manufacturing Company and built by Baldwin Locomotive Works in 1927 c/n 60185 and 60186. The locomotives were equipped with Beardmore engines. U. S. Patent 1,955,314



Westinghouse patent image covering the blower for the visibility end-cab locomotives built circa 1930 - 1936 jointly by Baldwin. This patent, an invention of Herbert Herr, covered traction motor blowers. Baldwin built several of the car-bodies and sent them up the track to Westinghouse for installation of the diesel engine and electrical apparatus. -- US Patent 1,997,299

sent to the WEMCO East Pittsburgh plant for fitting of the Beardmore engines and all electrical apparatus.

They operated in the New York City area as industrial switchers and were not reproduced. Baldwin Locomotive Works later adopted most of the idea of this patent for intrigal cast steel diesel-electric locomotive frames.

On May 15, 1929, just two months after Samuel Vauclain was bumped out of the Presidency of the firm, the second experimental unit rolled out of the doors at Eddystone. Baldwin 61000, was a four-motor boxcab. It was powered by a 1000-h.p. Krupp 6-cylinder, four-cycle, supercharged engine and WEMCO electrical gear. The original patents show two six cylinder engines connected to the generator via a gear box however, this idea was not used.

This was considered a heavy duty switcher with a top speed of 25 m.p.h. This second unit reportedly put on a successful 15,000-mile tour over the Pennsylvania Railroad into to the Midwest and western states over a total of six railroads and a stop at Oliver Iron Mining. The locomotive went into demonstration service.

There apparently were no offers to purchase this locomotive or copies, even though the market for new locomotives was still good. Both units were retained by Baldwin and after late 1929, were apparently parked and forgotten. Both locomotives were scrapped circa late 1941 or early 1942 at Eddystone. The locomotives had used a connecting arrangement between trucks that included a transverse connection via a pin at their inner ends to the side sills of a frame and carried the wheel thrust plus the buffing forces of the train, this avoiding any significant use of the engine bed for that purpose. That arrangement proved to be deficient in many respects and likely contributed to their quick retirement without follow-up orders.

Compounding the lack of interest in diesel-electric technology had been the fight for control of Baldwin, which started at the same time as the Westinghouse diesel contract. New Baldwin President, George Houston and his staff were apparently not pushing the development of the diesel-electric in the depression era for a second reason not well known. In a story about Baldwin and Samuel Vauclain by *Newsweek* in April

1935, it was noted that *“Last October [1934] the Union Pacific Railroad’s diesel-engined train, M-10001, sped from Los Angeles to New York on \$80 worth of fuel oil. A steam train would have burned \$280 worth of coal. But diesel’s initial cost averages three-and-a-half times that of the steam engine.”* This suggests the railroads would not embrace new technology solely on the initial capital costs. That idea was clearly wrong.

Houston was not making a concerted effort to alter the course of Baldwin’s steam locomotive business nor to chase after a bunch of 300-h.p. boxcars from ALCO-GE. Did Houston lack the specific knowledge to understand the transitions taking place in locomotive development at this time? Instead he focused on diversification of the business and acquisition of outside firms, almost all were non-railroad manufacturing businesses. One must consider however, Houston worked for the Fisher Brothers who held seats on the General Motors Board of Directors. The Fishers had acquired the largest locomotive builder in the world, holding all the resources to simply shut down up-start Electro Motive Engineering, at that point a new and wholly owned subsidiary of General Motors who did not have facilities to build their own locomotives.. Few if any resources were devoted to development or refinement of the Baldwin diesel-electric designs during the early years of Houston’s presidency.

Their immediate resources were instead directed to the purchase of new non-railroad manufacturing interests. There is no available record that might give any indication whether Houston was directed to focus away from the locomotive business on behalf of the Fishers.

Westinghouse, confronted with the problems of the post-World War I economy and a lackluster transportation market chose to move ahead with the development of a broad locomotive product line, only partly supported by the resources of Baldwin.

From 1927 through 1929 WEMCO fielded a total of five orders going to Baldwin, all for box

cab locomotives of less than 400 horsepower.

With the introduction of the Westinghouse Visibility cab in two body styles, Baldwin was contracted to build eight car bodies during 1930, one visibility center-cab, six visibility end-cabs and one standard center cab. The last one, c/n 61600, a 300 horsepower center-cab was the first car body to be finished and outfitted at the WEMCO South Philadelphia facility.

Westinghouse did not return with any additional orders until 1933, when they took two car bodies, that of a center-cab, c/n 61742 for the Cheswick & Harmer Railroad and a high horsepower visibility center-cab c/n 61750 to be used as a WEMCO demonstrator Number 12. Baldwin built no other diesel-electric locomotives during this time.

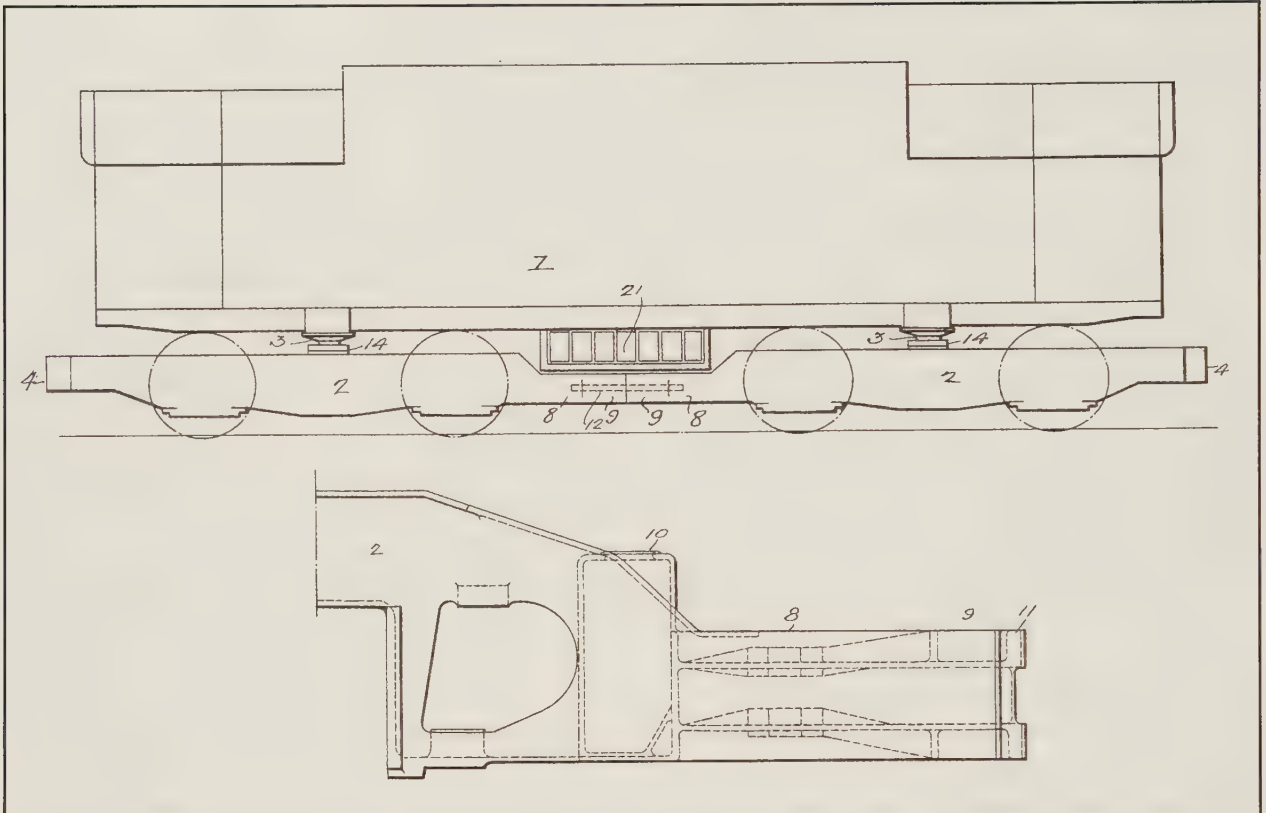
As the Great Depression left the railroads cash strapped and with a large surplus of steam locomotives, orders did not develop for WEMCO diesel-electrics. Just one 800 hp center cab was ordered in 1934, c/n 61757, WEMCO Demonstrator Number 13. The affairs of Westinghouse as a diesel-electric resource were wrapped up in 1936 with three 530 horsepower visibility end-cab locomotives for Great Lakes Steel, Numbered 3, 4 and 5, c/n 61983-61985. Thus Baldwin had allowed nearly ten years to lapse without aggressive or significant gestures toward entering the new and youthful technology of the diesel-electric locomotive. Meanwhile Electro-Motive Corporation had opened its first manufacturing plant at McCook, Illinois, and employed radical new standardized manufacturing technology in diesel locomotive production.

The Case for Diesel-Electric Diversification at Whitcomb

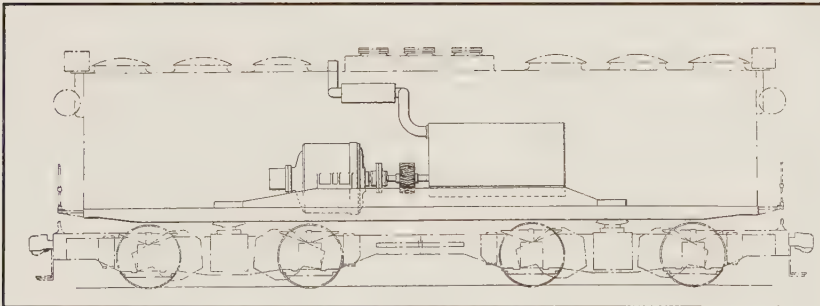
Was George Houston a visionary toward the industrial future for steam railroad locomotive production when he took over the helm at Baldwin in 1929?

The acquisition of Whitcomb in 1929, during Baldwin’s public diversification was no accident.

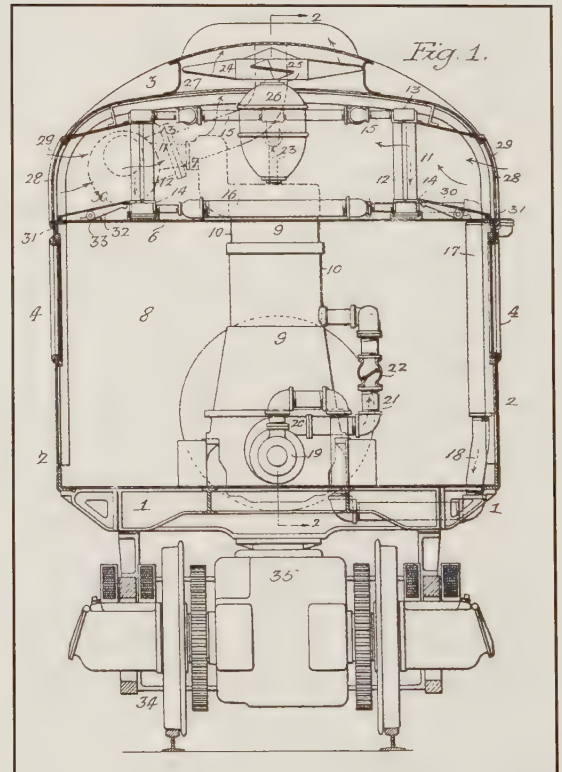
Baldwin 61000



Frame patent showing truck connections for Baldwin 61000. This patent was by Conrad C. C. Burkhardt. It was filed August 30, 1930 and was issued April 19, 1932.-- From United States Patent 1,855,094



ABOVE This is a side view of BLW 61000 taken from US Patent 1,787,368, issued December 30, 1930. The patent was filed October 31, 1928. It was to cover the frame improvements invented by Harry Glaenzer and Conrad C. C. Burkhardt. RIGHT: Conrad C. C. Burkhardt filed a patent covering the cooling system on February 11, 1927. It was granted as Patent 1,752,230 on March 25, 1930. -- From United States Patent Office



That relationship between the two locomotive builders probably existed fifteen years prior and likely included a significant ownership interest in Whitcomb by Baldwin. The business relationship can be traced back to the year 1917, when Baldwin received orders for approximately 1,000 gasoline-mechanical trench locomotives for Russia, France, Britain and the United States Army. Baldwin produced a significant portion of the orders at Eddystone, but shifted some undetermined additional portion of the manufacturing to Whitcomb Locomotive, in Rochelle, Illinois, during November 1917. It is likely that Baldwin manufactured key components at Philadelphia and sent them to Whitcomb for finishing and assembly. It was not without its hitch. Baldwin-owned subsidiaries provided wheels, axles, springs, forgings and so on. Baldwin, in the tradition of its management style at this time, probably acquired a significant ownership interest in Whitcomb in return for shifting of the business to this small industrial builder.

Much of Baldwin's outside holdings were kept away from the public's eye. Some of these holdings were sold about 1923 and others were retained and enhanced. It appears Baldwin retained its ownership interest in Whitcomb, which gave it a complementing product line for its line of electric mine and industrial mules.

Having this established and reputable indus-

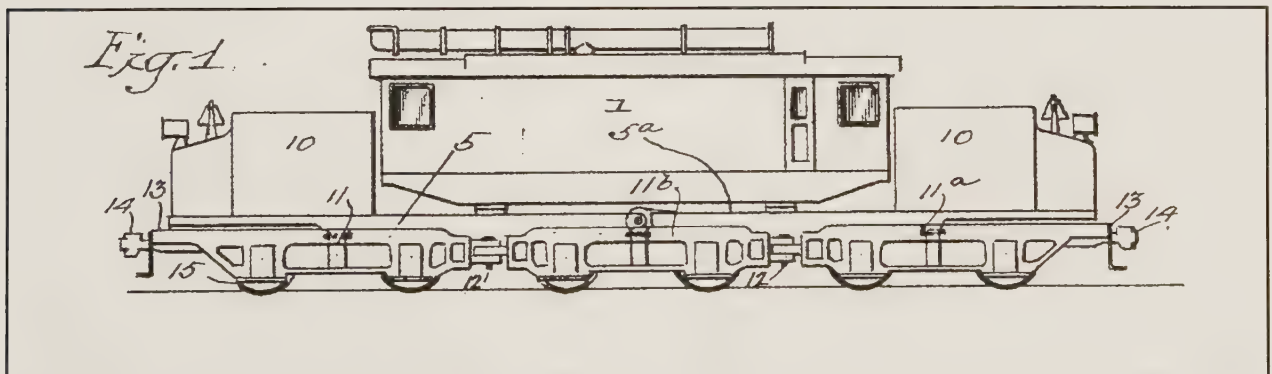
trial locomotive builder in the Baldwin portfolio in 1929, may have been the entry Houston sought to further develop, leading the Baldwin group into the days of the diesel-electric locomotive. With Whitcomb being bankrupt and an ownership interest by Baldwin, its complete ownership and control were probably assured via Baldwin's assumption of the assets during the reorganization.

It was in the year of 1929 that Whitcomb introduced its line of diesel-electric locomotives. These were developed based on Westinghouse earlier experiments.

Whitcomb built two 80 ton center-cab diesel-electric locomotives for the Chicago Milwaukee St. Paul & Pacific Railroad (Milwaukee Road) in 1929, just months after the formal Baldwin takeover. Number 5800, was delivered in November 1929 and Number 5801 was delivered in June 1930, c/n 50005.

Were these two locomotives to be Baldwin's entry into the Class 1 diesel-electric market via its subsidiary? Was Whitcomb intended to be a separate and distinct builder of diesel-electric locomotives for Baldwin? Was Houston well aware of the steam manufacturing traditions steeped into the workers at Eddystone? Perhaps scholars will make a future determination.

With BLW 58501 parked at Eddystone after testing and with Whitcomb under Baldwin con-



On July 23, 1931, Allen Wallace, of Baldwin filed this diesel-electric locomotive design patent. It was granted November 15, 1932. Wallace's design continued to embrace the bar style steam locomotive frame and connected trucks of electric railway practice. This design also used ballast weights to help improve adhesion. It was not built. -- United States Patent Office Number 1888190

trol, one might conclude the Whitcomb diesel-electric designs were more recognizable for the economic circumstances of the railroads at the time. It might also be that it was easier to develop this new product line at Rochelle, Illinois, where the traditions of steam were not a constant competitive issue and the technology was more easily understood without challenge.

Conrad C. C. Burkhardt, meanwhile was working on designs to refine the adaptation of electric trucks used under test locomotives 58101 and 61000. For whatever reason his line of designs held that the trucks had to work as the load and buffer device directly coupled to the train and that the engine bed should not be required to handle those forces of train dynamics and also carry the diesel engine and generator.

Burkhardt's design suggested an improved buffer between the trucks for transmitting thrust from a truck to the locomotive frame in order to relieve the center pin of excessive loads.

The two prior test locomotives had used an arrangement that included a transverse buffer connected at its ends to the side sills of a frame. That arrangement proved to be deficient in many respects, but Burkhardt's improvements and simplified buffer for transmitting thrusts from a truck to the underframe, were misguided. He filed for patent protection on June 8, 1935.

Baldwin had produced electric trucks for its electric steeple cab and box cab electrics for many years without significant problems. The other locomotive builders had already accepted as standard the truck and frame connections that largely remain in place at this writing.

As the plans for diesel-electrics came into focus in the engineering room, some attention was refocused toward producing an in-house diesel engine for railroad locomotives. Baldwin had owned the De La Vergne Engine Company four years when they at long last decided to make design changes to allow its use in railroad locomotive applications. The engines at the time of purchase of De La Vergne by Baldwin, were large units of low r.p.m. originally designed for station-

ary, industrial and marine applications. These engines were not suitable for use in a locomotive. In 1935 De La Vergne introduced its new four-stroke model "VO" engine specifically for use in railroad locomotives. It was proposed as a six or eight in-line cylinder model, mounted within a cast iron bed. The engine had solid injectors and produced 600 horsepower and 900 horsepower when normally aspirated in 6-cylinder and 8-cylinder versions. The individual cylinder bore was large, with a 12 1/2-inch bore and 15 1/2-inch stroke, and a maximum engine speed of 600 r.p.m. At long last this gave Baldwin the key component it had lacked, a power plant to match up with WEMCO electrical apparatus.

The model VO engine received no further modifications until 1939 when the engine frame went from a cast unit to a steel welded unit and a change in method of crankshaft support.

62000, A Baldwin or Whitcomb Locomotive?

Things were so bad at Eddystone by 1934 that the few engineering staff employees they were able to keep employed worked 20 hours every third week. Then, in 1935, just as Baldwin entered receivership, they began design work on a 100-ton switcher for production at the Whitcomb plant. It was designed to use the new 600-h.p. 6-cylinder "VO" De La Vergne engine, in the first apparent marriage of the De La Vergne engine into a Baldwin designed diesel-electric locomotive.

The locomotive project was shifted to Eddystone for production and given Baldwin c/n 62000. Oddly, it used Allis-Chalmers electrical equipment with the air compressor and traction motor blowers driven by separate electric motors. Why it did not use proven Westinghouse electrical apparatus is not known. Perhaps Hous-ton needed to gain a clear path for Baldwin's long-delayed entry directly into the diesel-electric market and needed to terminate some prior agreement with Westinghouse in this matter.

Westinghouse decided to exit the locomotive market and began negotiating a marketing agreement with Baldwin for the construction of future diesel-electrics. The Allis-Chalmers electrical equipment had been purchased before the WEMCO agreement and was installed in the 62000 as planned.

A deal was struck between WEMCO and Baldwin in June 1936, and the product line Baldwin had so long resisted was now firmly in its lap, but neither Baldwin nor Westinghouse apparently knew how to manufacture or garner resources to successfully market this new technology. The Beardsmore engine was not included in the contract and Westinghouse gave up its manufacture, perhaps a mistake since it was a tested and known diesel engine in railroad applications. The new Baldwin VO was neither known nor proven in railroad applications. WEMCO, maintained an active interest in diesel-electric locomotives, but only as an electrical apparatus supplier to locomotive builders.

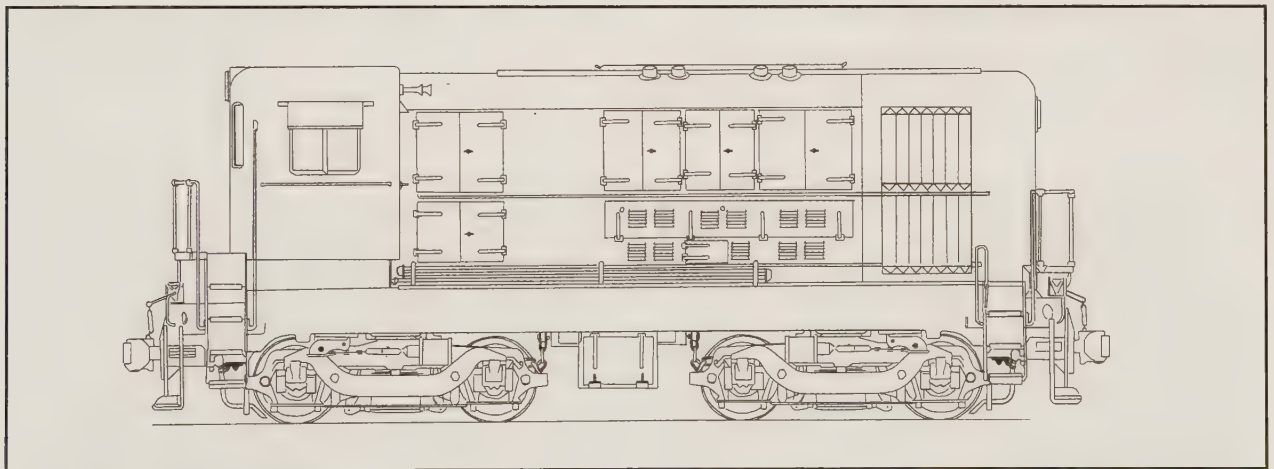
Baldwin 62000 locomotive foundation was a cast steel underframe with integrally cast mounting pads for the auxiliaries, as well as a cast-in fuel

tank, battery box, sand boxes, draft gear pockets and corner steps. It was cast across the street at General Steel Castings. Thus Baldwin continued to embrace tried and true technology when the functionality and practicality of electric arc-welded fabrications had been proven.

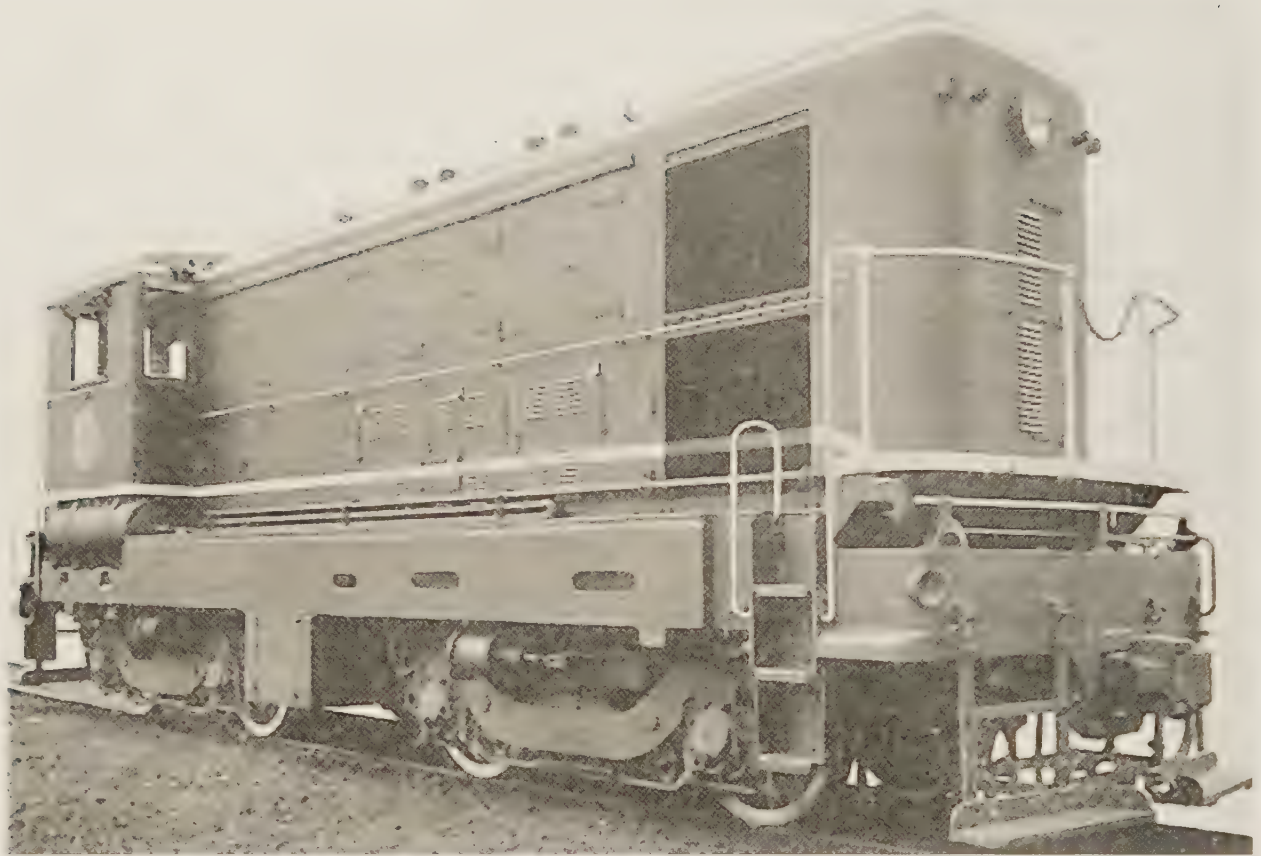
Baldwin 62000 made demonstration stops on several railroads. Two railroads placed orders, The New Orleans Public Belt Railroad ordered three 900-h.p. versions of the new Baldwin 62000. The Santa Fe purchased the 62000. NOPB 31, 32 and 33 were delivered in mid-December 1937 with 8-cylinder normally aspirated VO engines and WEMCO electrical gear. The generator was a WEMCO Type 486-B-2 generator and 376-E traction motors.

The three New Orleans units and the 62000 were the only units that were built in that carbody design.

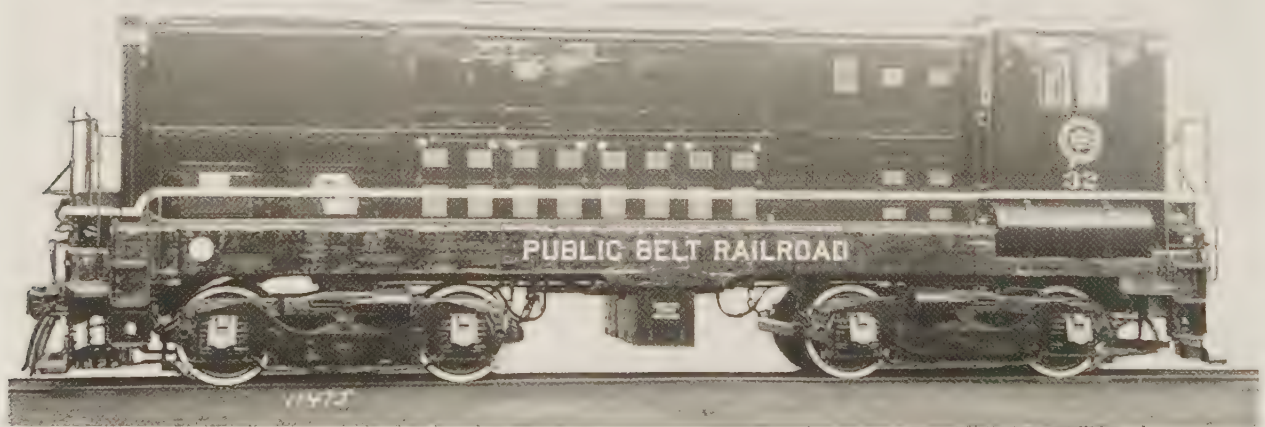
They were successful switching locomotives. They suffered from an excessive cost of manufacturing, largely thought to be with their complex cast frames and motor-driven auxiliaries. Price-wise, they were not competitive with the American Locomotive or Electro-Motive diesel-electric



Baldwin began design work on a 100-ton diesel-electric switcher for production at the Whitcomb Locomotive Works plant in Rochelle, Illinois. It was designed to use Baldwin's new 600-h.p. 6-cylinder "VO" De LaVergne engine. The locomotive project was shifted to Baldwin at Eddystone for production and given Baldwin c/n 62000, delivered June 22, 1936. It used Allis-Chalmers electrical equipment. The air compressor and traction motor blowers were driven by separate electric motors. The locomotive frame was of cast steel with integrally cast mounting pads for the auxiliaries, as well as a cast-in fuel tank, battery box, sand boxes, draft gear pockets and corner steps.



Baldwin 62000, was on the drawing boards to be manufactured by Whitcomb Locomotive Works at Rochelle, Illinois, but ended up coming out of Eddystone as a Baldwin product. It was designed to use the new 600-h.p. 6-cylinder “VO” De LaVergne engine, in the first apparent marriage of the De LaVergne engine into a Baldwin designed diesel-electric locomotive. The Atchison, Topeka Santa Fe Railroad purchased the 62000.



New Orleans Public Belt Railway locomotive Number 32 The NOPB ordered three 900-h.p. versions of the new Baldwin 62000. NOPB 31, 32 and 33 were delivered in mid-December 1937 with 8-cylinder normally aspirated VO engines and WEMCO electrical gear. The three New Orleans units and the 62000 were the only units that were built in that carbody design.

tric switcher products available at the time.

Baldwin needed to rethink the casting of its locomotive beds and find ways to make the first diesel-electric locomotives more cost competitive in a nearly dead steam locomotive market.

While General Motors and Charles F. "Boss" Kettering pushed to get into an evolutionary locomotive market, General Electric and American Locomotive had taken a lead role and were showing their demonstrator models by 1930. Baldwin, under the leadership of Houston did little of substance and allowed eight critical years to pass before they stepped up to the plate with a modest offering. Ironically Baldwin did not aggressively enter the diesel-electric market until after the transfer of control of Baldwin by the Fishers and the dismissal of Houston in 1939.

Westinghouse had made a strategic mistake by not looking into a line of high speed locomotives when it entered the marketplace. Instead they focusing their efforts on lower speed tractive effort and a market based on industrial users. With the fortunes of the times in hand, the underdog, EMEC had come into the ownership and control of General Motors and fallen squarely on a titan race for the streamliner development and high speed passenger service of the 1930's, where success of the diesel-electric locomotive was finally proven.. Both Baldwin and Westinghouse should have been leaders in the development of that technology. Pullman, who built some of the streamlines had also built carbodies for Westinghouse. The Edward G. Budd Company was in Philadelphia and The Chicago, Burlington & Quincy Railroad was a solid Baldwin customer, but none apparently saw any reason to bring either Westinghouse or Baldwin into the race to build the diesel-electric powered streamliners.

In the end both entities wasted years in trying to develop a diesel-electric locomotive and an accepting market as competitors who embraced new technology pass them by. It proved to be a critical mistake for Baldwin.

A New Vision

On January 1, 1939, Charles E. Brinley was named president of The Baldwin Locomotive Works. Part of his direction from the Board was to put Baldwin actively into the diesel-electric locomotive business.

Brinley had to rebuild an understaffed and lethargic engineering department and build motivation and a focus with new direction.

The first visible changes were in the sales structure. The diesel sales department was established with H. V. Huleguard set in charge of that function.

Baldwin started production of its new line of diesel-electric switchers with the VO 660 model. The first to come out of the shops was c/n 62299 660 hp outshopped April 21, 1939. The VO660 was built for The Baldwin Locomotive Works as Number 299, and rolled out the door to become the Eddystone plant switcher. It featured a GSC cast steel bed and cast iron De La Vergne engine block.

The second locomotive also a VO 660 by designation was built at the same time but its lines were very experimental.

Baldwin engineers had become interested in welding as an economical and reliable method for some component assembly. This would, it was hoped, reduce the locomotive cost by eliminating pattern costs and the time to build a sand mould for one time use in making a steel casting, then clean-up of the casting. At the time of the 1938 reorganization the engineering department had decided to fabricate by arc-welding, a complete bed for the new line of diesel-electric locomotives. In addition, portions of the diesel block, the frame and base were also constructed by welding, opposed to the traditional method of casting this item or riveted fabrication.. It required setting up an area for welding, perhaps the training of welders and some fixturing to successfully fabricate the welded components for this test locomotive.

On June 4, 1939, Eddystone outshopped

The Baldwin / Electro-Motive Timeline

1930 - 1931

Baldwin Acquired the DeLaVergne diesel engine in 1931.

GM Acquired Winton Engine and Electro-Motive Engineering Company at Cleveland, Ohio.

1935

Baldwin Enters receivership February 23.

GM EMC breaks ground March 2, on a 74 acre site for a 200,000 sq. ft. locomotive plant in McCook, Illinois, near Chicago.

1936

Baldwin Built four diesel-electric locomotives. First De LaVergne "VO" engine applied in locomotive in 1937. No further diesel-electrics were built until 1939.

GM EMC LaGrange plant completes its first locomotive May 20 — a 100 ton 600 hp diesel switcher for the Santa Fe Railroad.

1938

Baldwin Exits Receivership.

GM EMD begins production of its own engine, generators and motors at the LaGrange plant.

1939

Baldwin Received orders for eleven diesel-electric locomotives

GM EMD The FT103 begins an 83,764 mile tour on November 25, over 20 railroads.

1940

Baldwin Manufactured 26 diesel-electric locomotives.

GM EMD locomotive production approaches one locomotive per working day.

1942

Baldwin Manufactured 108 diesel-electric locomotives

GM EMD stops manufacturing locomotives and begins production of 2,100 "567" engines for use for sub-chasers and U.S. Navy LSTs.

1943

Baldwin Manufactured 106 diesel-electric locomotives

GM Government orders EMD to resume freight locomotive production to help break up the war time transportation bottlenecks.

1944

Baldwin Manufactured 188 diesel-electric locomotives

GM EMD manufactured over 500 freight locomotives.

1947

Baldwin Manufactured 191 diesel-electric locomotives. Introduced 606NA engine in 1946

GM Electro-Motive celebrates its 25th anniversary. Locomotive production reaches 5 units per working day.

Baldwin c/n 62300, a diesel-electric locomotive VO 660 that was a testbed for the future of Baldwin diesel-electric manufacturing. It became Reading Number 36 (renumbered 60 in service) and was the first Baldwin switcher with a low hood and belt-driven auxiliaries.

Baldwin engineers, for various reasons, perhaps led by a significant ownership interest in General Steel Castings, elected to make the cast steel locomotive bed frame standard for all future production locomotives. Their logic in this decision might be brought to focus because the Standard Steel plant at Burnham was also pouring large steel castings and it had a surplus of manufacturing capacity.

The low-hood carbody styling used on the BLW Number 299 VO 660 was selected for its eye-appealing carbody lines, opposed to the somewhat boxy appearance of c/n 62300. The radiator, hood and engineers control panel were patented, as used on BLW 299. They included U.S. Patent 2,370,237 Locomotive Hood, inventor, Max Essl, filed May 25, 1942, and approved February 27, 1945, it gave a clean styling to the box area of the hood. U. S. Patent 2,371,501, Radiator System for Diesel Locomotives, inventor, Conrad C. C. Burkhardt, filed March 4, 1943, and approved March 13, 1945, added the front oval radiator grille. U. S. Patent 2,410,250, Locomotive Control Panel, inventor, Dana R. Staples, filed March 22, 1944, approved October 29, 1946, was for a smooth engineers control panel. The VO new carbody could accommodate either the 6 or 8-cylinder De La Vergne VO engine.

Baldwin made a significant change in the VO engine to meet a competitive threat of the 1000 hp switcher from Electro Motive by increasing its bore by a quarter inch from 12 1/2 inches to 12 3/4 inches, while retaining the 15 1/2-inch stroke. Through the larger bore and an increasing of the r.p.m. from 600 to 625, it yielded a 6-cylinder VO engine with an increase of 100 hp to output 1000 h.p., thus the new model VO1000.

The VO-1000's were built between Novem-

ber 1939 and July 1946. All were designed as yard switchers with MU connections optional.

Several visual changes occurred to the carbody styling. From November 1939 to May 1941, the trademarked circular front fan opening was used. It featured tall side radiators, and a single exhaust stack on left near the cab, with high front mounted headlight.

In June 1941, a rectangular pointed front radiator replaced the circular design with small side air intake toward the top of the car body. The headlight was partially recessed. The single exhaust stack was moved to the left near the cab.

The original Baldwin trucks were replaced in June 1942 by General Steel Castings Commonwealth trucks. A few minor changes occurred to body styling at the same time. Small side air intake moved to the top of hood.

From January to June 1945, production units changed from the single exhaust stack on left near cab to two stacks on left side. From July 1945, through the end of production in July 1946, the two exhaust stacked was changed to a four stack arrangement.

When Baldwin ended production of the VO's in July 1946, 723 units had been produced. This was the single largest model group to come out the doors of Eddystone in the diesel-electric product line.

1933 A Year For Technological Competition

Giant manufacturer Baldwin Locomotive Works was little aware that cross-town automotive component manufacturer, Edward G. Budd Manufacturing Company was about to thrust the railroad world into a technological revolution with a little help from up-start EMC Division of General Motors. Edward Budd had long held that formed (tubular) structural members of alloy steels, when welded together could provide equal or greater structural integrity as that of heavier castings, at reduced weight and reduced cost. He set out to prove it with his revolutionary designs, first



This photograph taken August 6, 1940, is of members of an A.A.R. committee meeting at Baldwin. Most of Baldwin's primary diesel-electric locomotive engineering group and several of those from Westinghouse are in the photo. In the background is Reading Number 80, a VO-1000 c/n 62402. The Baldwin engineers in this photo are No. 8, Max Essl, No. 13, Frank Deans and No. 14, Dana R. Staples. Others in the photo include two other Baldwin employees, three Westinghouse employees and ten representatives from eight other railroads. This type of locomotive was Baldwin's staple D-E product until the end of WW II.

applied to the framework of railroad passenger car seating 25 years earlier. This time it would be an entire streamlined passenger train manufactured of stainless steel and powered by a diesel-electric locomotive.

On April 7, 1934, the first Budd-built streamlined passenger train, powered by GMC's diesel-electric power plant rolled out of the Budd Manufacturing plant in Philadelphia. The train was christened on Wednesday, April 18, and began a five-week barnstorming tour over the Chicago, Burlington & Quincy Railroad. On May 26, the reopening day of the Century of Progress Exposition in Chicago, the train made the now historic Dawn-To-Dusk Dash from Denver to Chicago, covering 1,015 miles in 13 hours and 5 minutes. The train's average speed was 77.6 mph, breaking all long distance, nonstop railroad records.

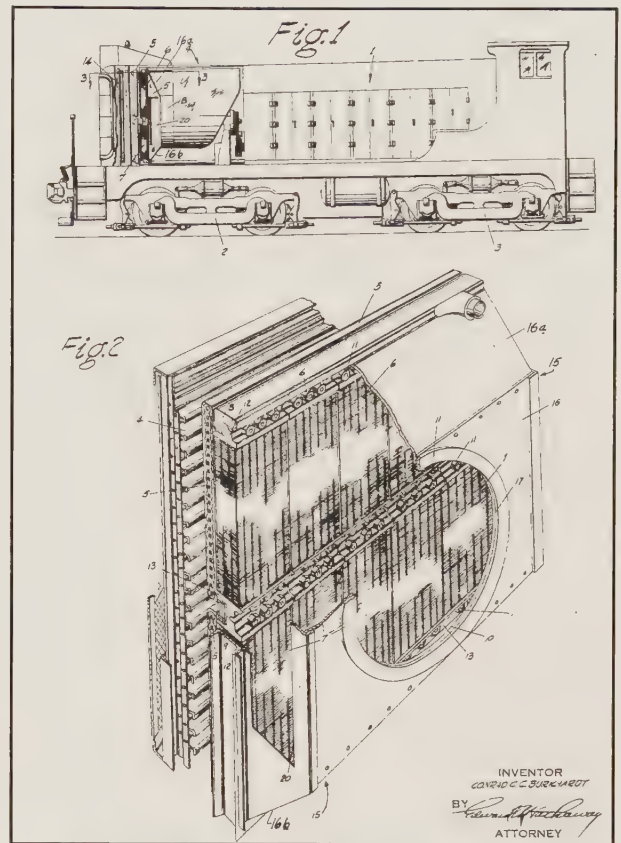
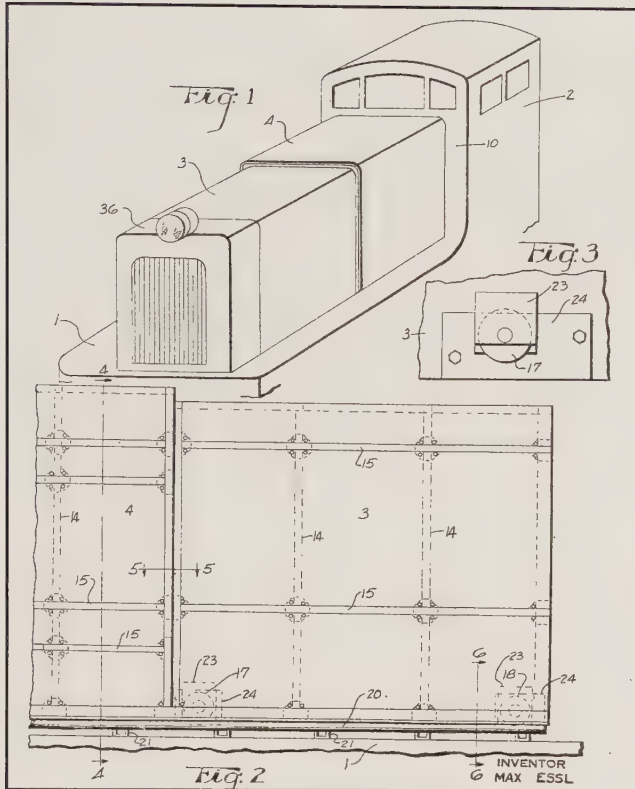
After that epoch-making trip of the first three-car Zephyr train, a rather complete change began occurring in the construction of high speed Die-

sel-electric locomotives, for which Baldwin had truly not considered the implications or their future business.

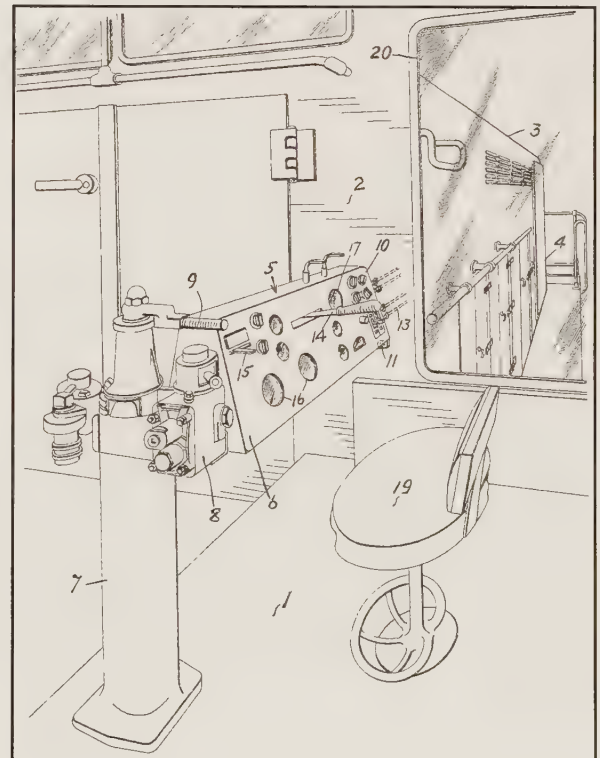
Subsequent to that time the diesel builders formerly used castings plus the riveting and bolting of car or diesel-electric locomotive bodies. Budd demonstrated that an all-welded assembly—at least when using ferrous metals for such construction would thrust locomotive manufacturing into a completely new realm that flew in the face of traditional thinking.

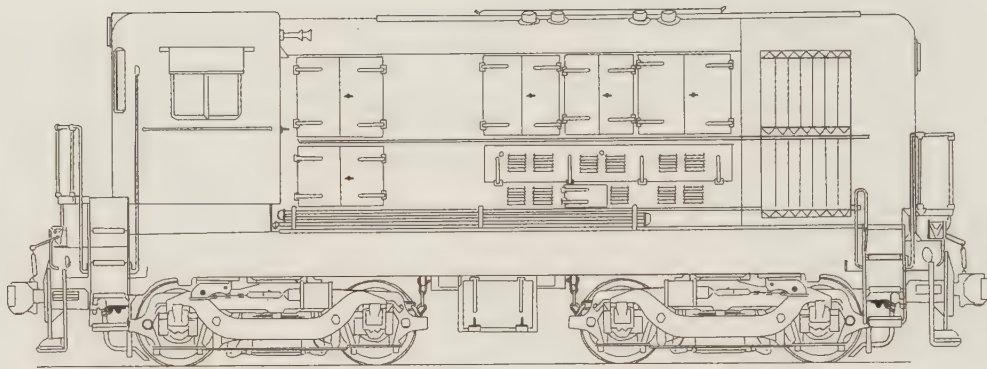
The railroads and other locomotive builders quickly understood the experiences gained in the daily performance of the new diesel-electric passenger locomotives under very strenuous schedules were not only responsible for the practically complete replacement of the rivet joint by electric arc welding, but they did much more than that. They were the reasons for inevitable new developments, which proved important in adoptions of electric arc welding in numerous other fields of manufacturing endeavor for the railroads.

THE VO PATENTS

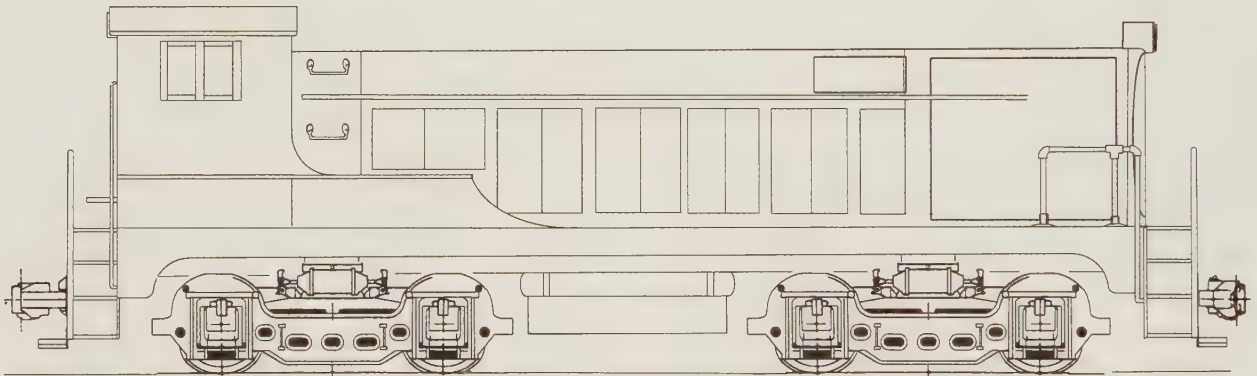


(TOP LEFT) U.S. Patent 2370237 Locomotive Hood, inventor, Max Essl, filed May 25, 1942, and approved February 27, 1945. (TOP RIGHT) U. S. Patent 2371501, Radiator System for Diesel Locomotives, inventor, Conrad C. C. Burkhardt, filed March 4, 1943, and approved March 13, 1945. (BOTTOM RIGHT) U. S. Patent 2410250, Locomotive Control Panel, inventor, Dana R. Staples, filed March 22, 1944, approved October 29, 1946.

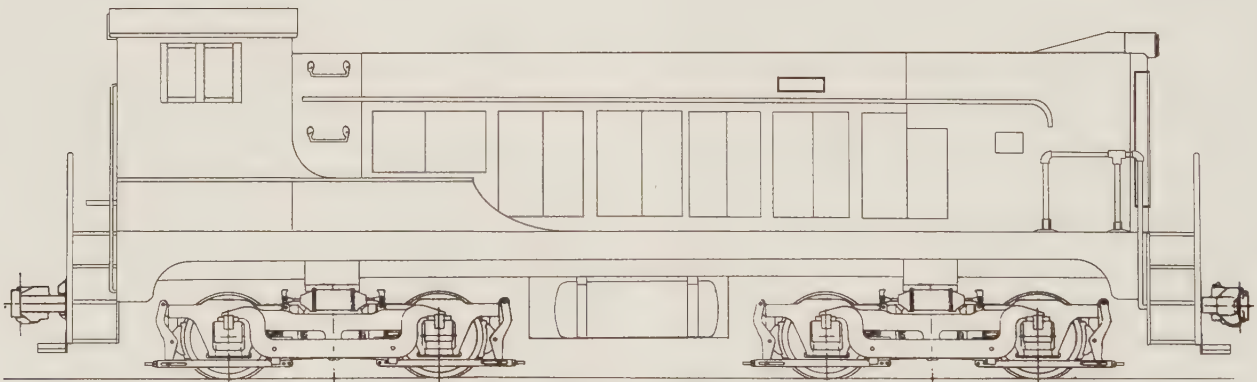




Baldwin 62000, the prototype for Baldwin's future line of diesel-electric locomotives. 600 hp.



Baldwin VO 660 with Batz trucks. This truck was not used on production models.



Baldwin VO 660 with standard trucks. This truck was used on production models. Note the car-body styling has changed on the VO 660 from that of the prototype BLW 62000. It was used on most switching locomotives until the end of WW II on both the 600 hp and the 1000 hp models.

The technological advantages of welded vs. riveted construction with a specific view to high speed or heavily scheduled locomotives were many:

1. Uniform distribution of stresses throughout the car body.
2. Very marked reduction of the weight of the locomotive in reference to its power output.
3. Adoption of stronger materials for car body construction.
4. Decreased cost of production.
5. A stronger, more ductile bond between the welded members.
6. Neater appearance.
7. Much better resistance of joints to repeated stresses, at ordinary and subzero temperatures.

Baldwin was not prepared to answer this kind of competitive challenge with a comprehensive change in manufacturing technology and did not possess a reliable design at the time from which a high speed and high horsepower diesel-electric locomotive could be rapidly built.

Railroads had traditionally demanded riveted assemblies or cast iron and cast steel components for locomotive construction. Baldwin, the former leader in steam locomotive construction was largely blind-sided by not only the performance of the streamlined locomotive, but also the sweeping technology. The welding techniques applied in the construction of Budd's car bodies followed the highest standards dictated by the fundamental necessity of absolute safety and at the time they were not in any published books.

Baldwin's diesel-electric design team; Conrad C. C. Burkhardt, with support from Harry Glaenger and Allen Wallace were traditional thinkers. They watched as the light-weight streamliners began rolling out the doors of the Budd plant but did nothing and it was another 22 years before Baldwin took a brief fling into the field of light-weight streamliners.

The 1939 tests of building two VO 660's, one with a conventional cast steel frame and the other with a welded steel frame using the conven-

tions of a traditional center-sill design posed to present challenges that they were not able to rapidly address.

The Budd manufacturing practices were taken back to EMC's new plant at McCook, Illinois, as well as American Locomotive's plant in New York. These included welding procedures and fixturing to build look-alike locomotives on a production line, were carefully dimensioned and produced in an assembly line style environment that Samuel Vauclain had envisioned when he started construction of the Eddystone complex in 1906.

What Baldwin focused away from was an all-welded locomotive, yet EMC, American Locomotive and General Electric came to embrace it in the manufacturing of diesel-electric locomotives. The all-welded approach employing lighter weight alloy steels, opposed to castings, and the introduction of precision templates and jigs cut down on component machining and proved itself on the manufacturing side. Why Westinghouse, itself, a large manufacturer of electric arc-welding equipment at this time, did not either adopt the technology or lead Baldwin into its greater use in these critical years is not known.

Baldwin chose to focus on designing and building diesel-electric switchers, for which EMC and American locomotive had available products. Recalling the Budd-built and Pullman Standard-built streamlines of 1934, were for high speed passenger service, it appeared a significant gap may have been perceived in the freight locomotive market. American Locomotive had already introduced its line-up of switchers in prior years and EMC answered the next year with its introduction of the NC series locomotives.

The railroads were looking for novel attractions to get people riding their trains. Streamlining got caught up in the just proven technological advances of the diesel-electric locomotive, yet Baldwin was laying-off thousands of people during the darkest years of the Great Depression. Skilled engineers were put out on the streets who, by suggestion, were trying to get Baldwin manag-

ers to see the significance of the Budd and Pullman Standard streamliners and the aggressive movement of American Locomotive toward a complete line of reliable diesel-electric locomotives.

Baldwin had lost steam locomotive market share to Cadillac *Super-Power* builder, Lima Locomotive, and couldn't see that its markets were being further eroded with the successful demonstration of the streamlined diesel-electric locomotive in high speed passenger applications.

Baldwin's modest entry into the diesel-electric switcher market was its four diesel-electric locomotives built in 1936, a project that had originally been envisioned for the Whitcomb Locomotive Works. The firm struggled to keep even a skeleton work force on the property while Electro-Motive began production of its own engine, generators and motors at the new LaGrange plant. By placing the production of all major components and apparatus in-house gave EMC a distinct competitive advantage which Baldwin could not enjoy.

American Locomotive had teamed up with General Electric and both were working jointly on a comprehensive product line of both-main line and switcher locomotives.

The next advance and another stunning blow for Baldwin was EMC's barnstorming tour of the United States with the main line freight diesel-electric demonstrators FT 103, which began an 83,764 mile tour on November 25, 1939, over 20 railroads. Baldwin simply did not have a demonstrator to roll out the doors.

By the end of 1940 other manufacturing interests were beginning to reawaken Baldwin's manufacturing capabilities. Its traditionally strong locomotive market was being converted into a wartime manufacturing center.

In the year of 1940 Baldwin manufactured 26 diesel-electric switcher locomotives and 47 steam locomotives plus Westinghouse electric mules for mine and industrial service. Even the minority steam builder, Lima Locomotive made a better showing than Baldwin with its 51 locomotive

orders. Their facilities were only one-tenth the size of Baldwin's. American Locomotive's showing was much better with 96 diesel-electric locomotives and 104 steam locomotives (produced at Schenectady) for a total combined output of 200 locomotives. EMC diesel-electric locomotive production was approaching one locomotive per working day. Baldwin was awakening to find it was no longer a factor in the markets it had formerly dominated with its line of steam locomotives.

Baldwin had lost control of its one time massive public relations machine, which remained virtually silent while the other builders took full advantage by flaunting their technology in every kind of railway and industrial trade journal. Both EMC and American Locomotive produced extensive articles about welding and its use in the manufacturing of both the diesel engine and locomotive car bodies between 1937 and 1950.

Entry into the Passenger Locomotive Market

Circa 1938 Baldwin's Southwark Division had begun experimenting with lightweight diesel engine designs, a far cry from the conventional thinking and non-railroad applications for the De La Vergne diesel. Baldwin management had a direct interest in developing a line of locomotives to fill their void in the passenger market, but nothing existed solidly on paper to take to manufacturing when it backed into the development via a design originally intended for Whitcomb industrial locomotive product line. Baldwin's Southwark Division came up with a design for their first Vee-configuration engine, as a compact 8" x 8" V-12 rated at 500 h.p. at 1200 r.p.m. It was dubbed Model LV and prototypes were built.

This LV engine was originally intended for a light mechanical-drive industrial switcher, and a prototype was designed and built, c/n 62320. It was a 500 hp 1-B-1 wheel arrangement and delivered in March 1939. It was built by Whitcomb for Baldwin, and delivered to Eddystone

with a Baldwin construction number. It was apparently not successful and scrapped at Eddystone.

Baldwin engineer Max Essl came up with a unique application of the Model LV in his conceptual 4000 h.p. single-unit locomotive. He patented the idea under U.S. Patent 2,317,849. He held other patents on this locomotive design.

Essl proposed putting eight of the LVs onto interchangeable skids and then inserting them into one carbody for Baldwin's prototype centipede, Baldwin Number 6000, c/n 64639.

Baldwin came up with the car body design and WEMCO worked out the electrical equipment designs. Since both had extensive experience in building large straight electric locomotives and both could boast of the highly successful Pennsylvania Railroad GG1s that became a basis for the new diesel-electric design for a Baldwin passenger locomotive.

Essl planned eight engine/generator/radiator sets on removable pallets placed crossways in the carbody. The double-ended unit would ride on an articulated 2-D+D-2 with cast steel underframes. Departing from the conventions of the GG1 which had two-traction-motors-per-axle configuration, Westinghouse went with one mo-

tor per axle.

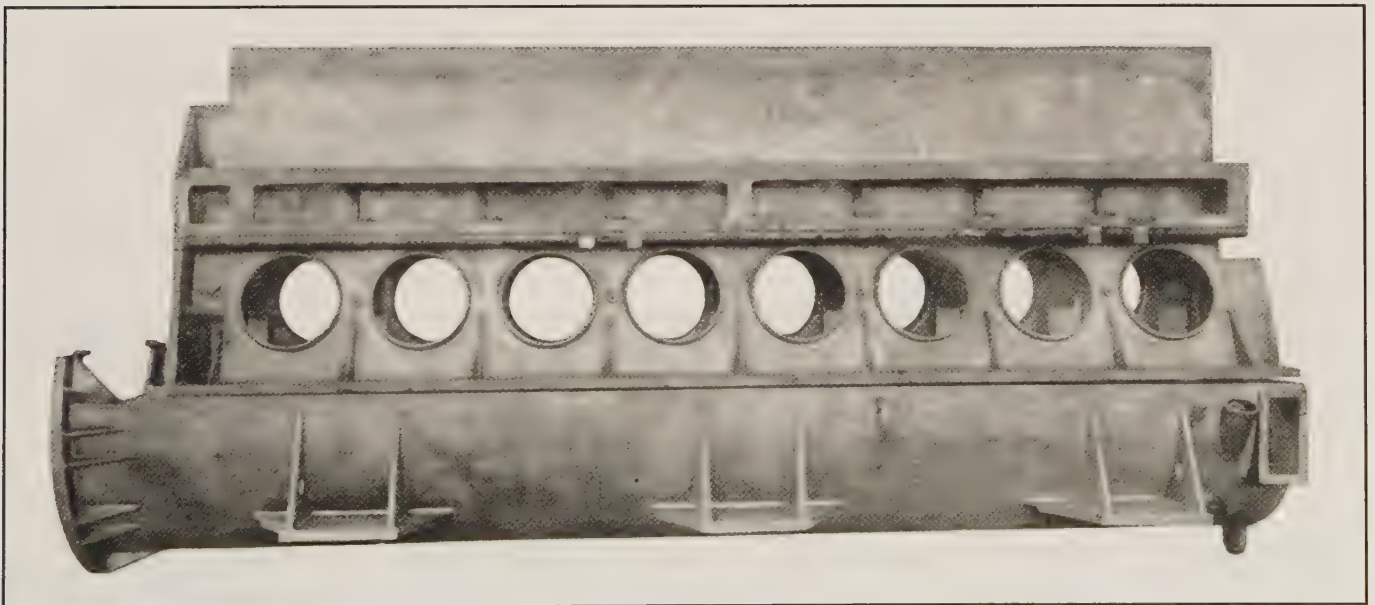
Baldwin's Southwark Division had moved into improvements of the LV engine and came out with the "400-Series" supercharged 9W' x 9W' four-cycle engine. It was an enlarged version of the LV and generated 700 h.p. in a V-8, dubbed Model 408.

Model 400 Series Engine

This new model engine for the centipede passenger diesel was designated as the 400 series and in its 8-cylinder configuration was model 408. The design of a supercharged Vee engine capable of higher horsepower ratings than were possible with the model LV engine. It was authorized for prototype production in September 1939. This provided for the manufacture of an 8-cylinder laboratory engine.

The engine was a four-cycle operation, and was initially rated 700 horsepower. It was subsequently uprated to 750 horsepower. Supercharging of the engine was accomplished by means of a gear-driven Roots blower.

Baldwin managers ordered construction of nine production model 408 engines, eight to be used for powering the centipede prototype road locomotive and one engine for powering a proto-



All welded engine block for a De La Vergne eight cylinder diesel engine circa 1944.

type 660 h.p. switcher.

In early 1941, two additional model 408 engines were added to the production order for use in powering a proposed heavy duty, 1,500 horsepower switcher c/n 64640 authorized March 1940. This project was abandoned on government orders in April 1942, due to the start of WWII. One additional engine was to be built as a spare.

While the twelve engines were awaiting construction, tooling had to be made, patterns made, castings poured and jig and fixturing assembled for weldments. The efforts were slowed and most of 1941 was consumed with the engines still not in manufacture. Baldwin's manufacturing effort was being focused on war materials for the Brits prior to the entry of the United States into the WW II.

Beginning in 1942, the design work was gradually resumed and ultimately War Production Board authorization was given for the prototype centipede locomotive project to proceed with limitations, but on a low priority schedule.

This required Baldwin to subcontract the manufacture significant engine components to local job shops. It gained nothing for Baldwin's in-house capabilities and yielded higher manufacturing costs.

Baldwin engineers, due to the higher prototype costs, went back to the drawing board and concluded the centipede could be completed and

tested with only four of its eight engine-generator sets installed. On this basis, only six model 408 engines were produced: It included the laboratory engine, four engines for the centipede locomotive, plus a spare locomotive engine.

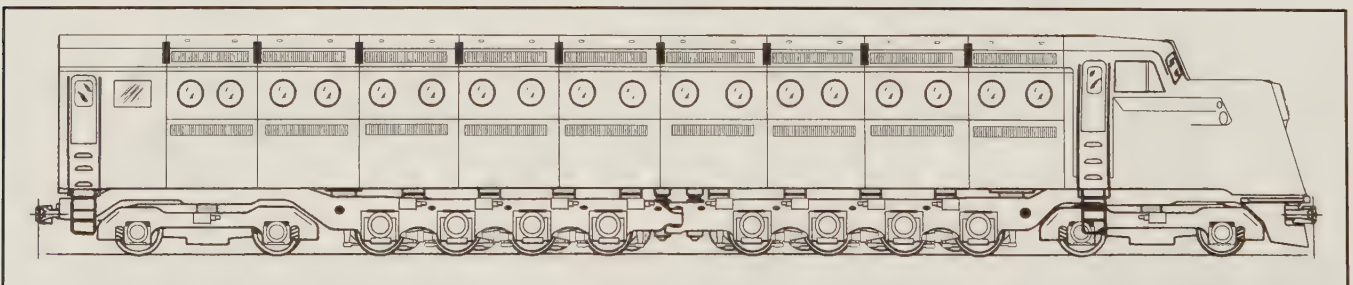
Baldwin authorized construction of a prototype diesel in early 1940, c/n 64639 as a single-ended unit on an articulated frame. Southwark began building engines and the locomotive division began work on the car body and running gear designs.

Delayed by the production demands for war materials, Baldwin demonstrator 6000 finally rolled out the doors in August 1943, as a 3,000 hp unit. The locomotive contained only four of its eight engines. Road tests on the Reading and Baltimore & Ohio Railroads, were conducted and the locomotive attained 90 mph speeds. It reportedly performed well.

Two prototype 12-cylinder engines in the Vee configuration were authorized for United States Navy testing in July 1942. This model was designated as 412. These supercharged engines were rated 1,125 horsepower at 1,050 rpm. There was no additional interest.

The 400 series engine program was suspended in 1944 when it became evident that after the end of WWII, higher horsepower engines would be required in order to be competitive in locomotive production.

The centipede car body was reconfigured to



Prototype Baldwin passenger diesel-electric locomotive Number 6000. It introduced the centipede wheel arrangement. The front end was styled after Otto Kuhler's DL 103 design for American Locomotive. It was not rolled out for testing until WW II had broken out and was not duplicated. It only ever contained four of its eight palletized diesel-electric generators. The locomotive was never sold and the running gear was salvaged for Searboard Air Line Number 4500 -- drawing by author

use six Model 408 V-8s for a yield of 4000 horsepower, but the two additional engines apparently were not installed. After initial road tests the 6000 was retired to Eddystone. It was never fitted with its remaining four engines. The locomotive was salvaged with its underframe and some carbody components used in the first Centipede c/n 71579 for the Seaboard Air Line in December 1945.

Baldwin's acknowledged its production costs were too high to compete against the newer and better manufacturing processes that EMD was using in its new plant at LaGrange, Illinois. It lowered their manufacturing costs. With the war well under way, it did not help in trying to refine the locomotive or improve manufacturing costs.

During 1944 the War Production Board authorized Baldwin to construct two prototype passenger units. Baldwin went with conventional wisdom and the format that had proven itself so well with the EMC slant-nosed E-units and the American Locomotive DL109. Baldwin mounted a pair of 6-cylinder, 1000-h.p. VO engines in a carbody similar in appearance to the unfortunate 6000. The two units, 2000 and 2001, rode on A-1-A Commonwealth trucks similar to those under the Alco DL109.

The two units were not identical. The 2000 had its engine sets facing the same direction, with generators both facing forward, while the 2001 turned the front engine around so that both generators faced each other in the center. This was to evaluate the economies of the internal configuration, where the 2000 simplified radiator piping and the 2001 had a more compact wiring package. When the National Railways of Mexico bought the two demonstrators, it ordered a third unit, 6002, which had the arrangement of the 2000, that favored the radiator piping.

With the exception of 30 cold-weather 1000-h.p. six-motor units delivered to Russia during the war with "covered wagon" carbodies, the three NdeM units were the only road units powered by the VO engine. The NdeM's single-unit order, 6002, delivered in August 1946, was the last

locomotive of any kind built new with a VO engine.

War Production Board Controls

The War Production Board was established: by the Office for Emergency Management (OEM) under Executive Order Number 9024, January 16, 1942, superseding the Supply Priorities Allocation Board and, by Executive Order 9040, January 24, 1942, the Office of Production Management.

It was formed to direct war production and the procurement of materials in World War II. The chairman, Donald M. Nelson, (1942-44;) was Chief Merchandising Executive of Sears Roebuck and Company, a Chicago mail-order giant. Julius A. Krug, (1944-45,) was granted sweeping powers over the nation's economic life. The WPB converted and expanded the peacetime economy to maximum war production; controls included assignment of priorities to deliveries of scarce materials and prohibition of nonessential industrial activities. During its three-year existence the WPB supervised the production of \$185 billion worth of weapons and supplies. Businessmen serving with the WPB were sharply criticized by a Senate committee headed by Senator Harry S. Truman.

The WPB organization changed frequently, and disputes with the armed services occurred. After the defeat of Japan, most restrictions were quickly lifted, and the WPB was abolished in November 3, 1945. The Civilian Production Administration was set up to take over the remaining WPB reconversion functions.

Successor Agencies: Civilian Production Administration (CPA), OEM (1945-46); Office of Temporary Controls (1946-47); Department of Commerce as liquidator (1947).

On April 4, 1942, the War Production Board placed strict controls on Baldwin and other locomotive builders. The WPB order forced Baldwin to drop "all design and construction work related to prototype engines and locomotives," This put

a real crimp in its development and prototype construction work for diesel-electric locomotives.

Baldwin was lagging in the development of a complete line of diesel-electric road locomotives

and it was three short years since its first significant production orders had arrived. (11 units in 1939, 26 units in 1940 and 84 units in 1941.) The WPB's action was quite adverse to Baldwin, as well as other locomotive builders.



New York, Chicago & St. Louis Railroad (Nickel Plate Road) VO 1000 builder's photo -- BLW photo

EDDYSTONE

Book 1

1906 - 1939

The Baldwin Locomotive Works at Eddystone

1906 - 1956

This volume is the first of two that explores The Baldwin Locomotive Works at its massive facilities in Eddystone, Pennsylvania. Baldwin is synonymous with steam railroad locomotive construction. It was a single site manufacturing plant until the upturn of business in 1906, when expanded foundry and machining capacity became necessary. Instead of attempting to buy ground somewhere in the immediate Philadelphia neighborhood and build another multi-story building, they bought the abandoned Gunsen Iron Foundry at Eddystone, Pennsylvania, twelve miles south. The foundry and 180 acres of pasture land comprised the first modest investment in what would become a 600 acre manufacturing complex. It was a gem in a highly concentrated manufacturing center on the Delaware River

Baldwin practiced vertical integration manufacturing long before that phrase was ever trendy. At differing times they owned all the raw materials, all the necessary manufacturing via steel mills, and fabrication plants to produce every single component for a locomotive. Eddystone itself was first expanded in significant ways at the start of WW I as a defense plant to handle military needs including munitions, rifles, bullets, shells, canons, speciality guns and canons plus non-rail vehicles such as army trucks. With the union situation at the Broad Street plant and its limitations of physical size, at the end of WWI the managers thought it more prudent to shift all production into the empty defense plant buildings at Eddystone during the 1920s.

BALDWIN: FIFTY YEARS AT EDDYSTONE Book 2 1940 - 1956, will be available in the first quarter of 2013 and will cover WW II production of steam locomotives and war materials, the development of the diesel-electric locomotives, the end of steam and the end of diesel-electric production. Both are a must have for the serious historian.



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